Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY McGRAW PUBLISHING COMPANY, INC.

Volume 69 NEW YORK, SATURDAY, MAY 30, 1914 Number 22

Winter Operation of Movable Dams

OPERATION of movable dams in winter in severe climates is the subject of a short article on page 618 of this issue. As the climate in parts of this country is just as severe as that referred to, American engineers should take particular interest in the experiences narrated. Stoney gates, which are considered one of the best types available, are not suitable where extreme cold is to be expected, because they give too much opportunity for the formation of ice in inaccessible parts. Sliding gates are somewhat better although sometimes even they cannot be operated. Rolling dams have been found most satisfactory, and no difficulty has been encountered in keeping them in operation. In one case, where the attendants at first believed it impossible to move the roller because of ice formation, the dam was ice free and in operation two hours later. These experiences are particularly interesting at the present time, for rolling dams were adopted for important projects in this country during the past year, and a number of other installations are under consideration.

Load Transmission Through Soils

THERE is need for more exact data than exist at present on the transmission of loads through soils of various depths. Bridge and culvert designers are constantly making assumptions as to the distribution, while the same factor also enters into many special problems as, for example, the design of subway roofs not far below the ground surface. For this reason the account in this issue of the experiments under way at the Pennsylvania State College is of special interest. They indicate that when the series is complete much sorely needed information will be at hand. The tests reported on page 608 are with sand, and indicate that the method employed is reliable. The chief conclusions so far reached are that the maximum transmission for loads up to 300 lb. per square foot and sand depths of 12 in., and also for loads up to 5400 lb. per square foot and 23-in. sand depths, is 20 per cent. Furthermore it appears that the point at which a marked change occurs in the per cent of transmission due to eccentricity is at a distance from the center equal to the width of the weighing strip and that at this point the maximum transmission is 16 per cent.

American Society at Baltimore

BALTIMORE'S engineering works will be on exhibition next week before, to them, the most critical audience in the country—the American Society of Civil Engineers, which opens its annual convention in that city on June 2. After the great fire of 1904, which destroyed $60,000,000 worth of property, Baltimore entered upon an era of reconstruction and today the evidences of the engineer's services in the upbuilding of the city are everywhere apparent. It would be difficult to choose a place which would prove more attractive as a browsing ground for the technical man than Baltimore. In order to give the visiting engineers a bird's-eye view of the locality from the engineering angle, the Engineering Record asked Calvin W. Hendrick, chief engineer of the Sewerage Commission, to prepare for this issue, preceding the convention, an article pointing out the salient features of the city's more important public works. This he has done. The views on the front cover suggest the variety of works that are to be seen, and on page 605 is a map showing the locations of engineering structures worth visiting. The educational value of engineering inspection trips cannot well be overestimated and Baltimore offers exceptional opportunities of this sort.

Rules for Railroad Evaluation

SO many phases of railroad evaluation were analyzed in Mr. Wilgus' report on the appraisal of the Lehigh Valley that it is hazardous to say which parts are most important. The broad aspects and principles of valuation, the study of Lehigh Valley conditions, the masterly analysis of overhead charges—these were covered in brief in the Engineering Record of May 16. In this issue, page 613, is an abstract of another section of the report, and this should be especially useful to those who, with the general method of attack predetermined, are required to gather and assemble the information in field and office. These "Rules for Evaluating a Railroad Property" are, in curtailed form, the instructions prepared by Mr. Wilgus for the guidance of his staff. Space does not permit presentation of more than a suggestion of the admirable forms, diagrams and tables, and a discussion of the text is hardly necessary. Special mention might be made of the treatment of land, the emphasis laid on concealed conditions and the analyses of depreciation of individual items. It is futile, however, to attempt to emphasize in this brief space all valuable features which are treated in the abstract. This note will serve merely to emphasize the importance of the article and secure for it the wide reading it deserves.

Double-Purpose Dams

CONTRARY to views frequently expressed in this country the construction of double-purpose dams is not necessarily an engineering mistake. This was demonstrated recently in one of the series of articles by H. A. Petterson in this journal and is proved by experiences in Germany, where dams designed both for flood prevention and waterpower development are in successful operation. Naturally the capacity of the reservoir under the dual-purpose condition differs from that of one built for a single purpose only, while the storage for what may be called the secondary end is largely affected by the retention necessary for flood prevention. One of the dams in Germany used for two purposes is described on page 625 of this issue. The design provides for two spillways at different elevations, the lower being placed at the level required for the hydroelectric installation. Above this spillway, which is an arched orifice in the dam, the structure rises about 30 ft., giving a capacity for flood storage of approximately 30,000,000 cu. ft. Of course, it is not possible to theorize from so small a reservoir to the large basins required on some of the watersheds now under study in this country without taking full account of increased costs and their relation to the return from the power developed. Nevertheless, it is plainly an error to dismiss the possibility of a dual-purpose dam without adequate consideration.

Building Height Limitations

FOLLOWING close upon the exhaustive investigation of building height limitations in New York comes an interesting and convincing study of the problem in Minneapolis. The Minneapolis Civic and Commerce Association has taken great interest in the movement and has actively supported an ordinance, reproduced elsewhere in this issue, limiting the height to 140 ft., or one and three-fourths the width of street on which the building abuts. Moreover, it has prepared an admirable summary of the reasons favoring limitation. To any one of open mind the argument carries conviction. The evils of crowding, poor light and fire danger attributable to the skyscraper, the poor investment returns therefrom, restrictions in European and American cities are all treated briefly but pointedly. Five diagrams show graphically the influence of the skyscraper on lighting. Despite the excellence of the presentation, however, there is still opposition, which probably indicates that the booklet has not had as wide circulation as it deserves. Crowding in Minneapolis has not reached the intolerable degree which obtains in Boston or New York; otherwise the citizens would be as ready to accept a limitation ordinance as are their brethren in the East. As Arnold Brunner, a well-known New York architect put it recently, "Our city is in the mob stage. We need regulation of our buildings just as we need regulation of our traffic. Everybody said that that would not work well here, and it works so well that nobody would go back to the old system."

Shipping in the Hudson

ON her arrival at and departure from New York on her maiden voyage the Vaterland seriously interfered with shipping. On her arrival about four hours was consumed in docking, due in the first instance to some barges which obstructed the entrance to her slip. On leaving, for some reason yet unexplained, but obviously connected with her commander's desire to be in deep water before turning, the stern backed within a few feet of the Manhattan piers. A coal barge was sunk, two lighters badly damaged and two goodly sized vessels torn from their moorings by the strong wash from the giant's propellers. While her 50-ft. increase in length over her predecessors and her 8000 additional tons hardly account for her apparent unwieldiness, the difficulties of docking in a river about 4700 ft. wide with 900-ft. piers jutting out to reduce the clear width to about 3000 ft. have been growing enormously with the increase in size of vessels. It is not unusual to see as many as twelve tugs laboring to berth one of the large ships.

These conditions will give strength to the agitation in favor of dockage for the largest vessels elsewhere than in the Hudson River. Heretofore the chief argument has been the opposition of the Government to the extension of the pierhead line, but if the vessels themselves are too unwieldy the lengthening of slips by encroachment on the land, as is being done for the 1000-ft. piers under construction at Forty-fourth Street, will avail nothing. Dock sites at the east end of Long Island, in Jamaica Bay, on Staten Island, and at Bay Ridge on the Brooklyn shore of the Upper Bay have all been proposed. They offer both advantages and disadvantages, but with the improvement of rapid transit facilities from Manhattan to some of these sites there is no doubt that the opposition to dockage of the 900-ft. ship in the Hudson will be greatly stimulated.

The Mellen Disclosures

RAILROAD men who cannot understand the hostility of the public and who bewail the tendencies of Congress and of legislatures to enact stringent laws for the regulation of transportation companies are commended to a consideration of Mr. Mellen's testimony in connection with the Interstate Commerce Commission's investigation of New York, New Haven and Hartford affairs.

As president of the New Haven, all Mr. Mellen had to say when he was advised by telephone that an excessive price had been paid for the Westchester road was "Jerusalem!" Apparently he had even less to say about other transactions, but now that the financier who engineered most of the deals under examination has passed beyond the reach of a subpœna, Mr. Mellen appears on the stand and callously betrays the whole disgusting story of the looting of the New Haven.

Where Mr. Mellen stands is not the most important phase of this matter, but it is one to be taken into very serious account in judging of the effects of his testimony upon the public mind. Public opinion is not influenced so much by facts and logic as it is by appeals to the imagination, and nothing has happened in a long time that is so well calculated to prejudice the average man against the sort of railroad management that Mr. Mellen represents than the tone of and the atmosphere surrounding his appearance and his statements on the stand at Washington last week.

Having absorbed his own account of his status and actions as president of the New Haven, no one is likely to regard seriously his prescription for the cure of the evils of railroad administration. If all roads were as badly managed as was the New Haven under his nominal guidance, and with abject subserviency to the banker members of the board, it might be necessary, as Mr. Mellen suggests, to make railroads a government monopoly. Government supervision, such as we have to-day, and as it will be when extended by law giving the commission control over financial operations, still holds promise of affording the best solution of the railroad problem. This the Engineering Record believes in spite of what seems to have been Mr. Mellen's determination to represent New Haven management, if not railroad management in general, in the worst possible light.

Safeguarding Dangerous Tunnel Work

THE specifications for compressed air tunneling work, abstracted on page 609 of this issue, although not remarkable for much entirely new matter or radical features, are notable in that instead of being a combination of ordinary specifications they have been completely written new for this work, and are designed to cover very difficult construction as thoroughly as possible. While most of the features are in accord with recent high-grade practice, the points covered have not all appeared in any single specification and are usually left to the judgment and experience of the contractor and engineer. Their complete enumeration, and specific enforcement here by making them a part of the contract, emphasize their importance, provide definitely for their consideration in bids and payments, and place all of the bids on a uniform basis regarding the expense of safeguarding the work and the workers. The inevitable danger of driving subaqueous tunnels in soft ground is so great that the elimination of any part of the risk is important.

Besides ordinary precautions in compressed-air work a number of important ones not always exacted are here required and include the amount of fresh air to be delivered to each heading, a provision for reserve supply and plant, and a standard of purity of the air. The safety of the property and of the workmen are alike guarded by fireproofing and fire-extinguishing provisions and by heavy bulkheads. Heavy air pressures must be divided into two successive stages in the tunnel sections, and the use of a safety screen, following the shield at a short distance, to prevent the complete filling of the tunnel in case of a blowout, is required. Such a screen has long been recognized as important and its use would undoubtedly have saved the lives of six workmen drowned in a tunnel near Melbourne, in the disaster of April, 1895. The provision for the conduct of experiments and the recording of data by scientific bodies during the progress of the work is most commendable. Two suggestions for the improvement of these specifications occur to this journal. As the greatest physiological danger from compressed air is due to too rapid emergence, and as this was demonstrated by Dr. Leonard Hill as far back as 1906, when he recommended a speed of emergence of twenty minutes per atmosphere, it would be desirable to regulate the length of time for passing through the locks. This has been accomplished in tunnel construction at New York by the use of special regulating valves, which can be locked to permit the reduction of pressure at certain fixed rates only.

The other suggestion relates to the detection of the presence of poisonous gases. Several instances are on record of suffocation and explosions due to these gases, and, although it may not be necessary in this instance, certainly requirements for frequent tests to determine their presence are worthy of consideration when similar specifications are being drafted.

Different Ways with Trusts

AT the Foreign Trade Convention at Washington this week one of the most important subjects under discussion was the possibility of forming export associations for the purpose of successfully invading foreign markets. Years ago the success of the United States Steel Corporation in the export business led other manufacturers to think of joining their forces for foreign campaigns, but it was feared that such a combination would offend the law, and it was abandoned. The same plan has now come forward again, its proponents being emboldened by a lawyer's opinion that since the consummation of an export association's purpose—sale in a foreign market—is beyond the reach of our statute, it would be absurd to argue that the mere inception of the purpose in this country initiates a "conspiracy in restraint of trade." But of course there would be complaint from, if not restraint of, the trade of those who were left out of one of the proposed associations, and it is by no means certain that the absurdity of prohibiting combinations in search of foreign business would prevent action against them.

Germany, it has often been pointed out, has followed a policy toward trusts, which is the antithesis of our own. In respect to some phases of trade in Germany, combination is not merely encouraged; it is compelled, and where the law does not operate the Emperor does. It came out at one of the Vaterland celebrations that the understanding between the North German Lloyd and the Hamburg-American lines was the result of the intervention of the Kaiser. The same story is repeated more circumstantially in a dispatch from Berlin. At all events, the combination, however brought about, spells the supremacy of Germany on the oceans, and offers a striking contrast to the decay of our marine and to the spectacle at Washington, where our manufacturers have been trying to get up their courage to combine for a foreign commercial invasion.

Another contrast emphasizes the difference in method and results between German and American trust policies. In Germany potash mining is controlled as to quantity of production and price at home and abroad, by a trust which the government compels all mines to enter. Here our phosphate rock deposits (which happen like potash to be an essential component of fertilizers) are exploited by rival companies who are compelled to compete to so disastrous a degree that our phosphate resources are being exhausted without even the poor consolation that some one made money out of them.

All of which suggests that if we can ever get over the bitterness and the search for revenge that are at the bottom of our kind of "trust busting," we shall stop the crucifying of industry and national interests and encourage, under proper regulation, combination or other organization of business that means more business or better ways of handling our share of the world's work.

The Folly of Using "Bank-Run" Mixtures in Concrete

To obtain good concrete, accurate proportions are necessary. If correct proportions are not specified, or if the specified proportions are not observed, high quality cannot be obtained. When a 1:2:4 mixture is specified, there is no excuse for allowing a 1:6 mixture of cement and "bank-run" aggregate. Such a statement seems entirely unnecessary and yet the rule is being daily disobeyed.

If the gravel pit is close at hand, a peculiar mental inertia seems to overcome the contractor, in consequence of which the cement is mixed with the bank-run material, without separating the sand and gravel and remixing in the correct proportions. This is bad practice, since in practically every bank the sand is generally twice the volume of the coarse material. But to make matters worse, if a 1:2:4 mixture has been specified, the contractor thinks he will meet the specifications by using one part of cement and six parts of bank-run. Thus, instead of approximately one-quarter of a cubic foot of cement per cubic foot of concrete, only one-sixth of a cubic foot is obtained.

The idea then occurs that rather than take the trouble to separate the fine and the course materials, good concrete can be obtained by using one part of cement and four parts of the bank-run, but in most gravel banks the sand is about double the quantity of the coarse gravel instead of the reverse, which is to be desired. Thus, not only is less cement used per cubic foot of concrete, but the strength is decreased by the excess of sand. A report of analyses on samples of cement and bank-run, mixed in the proportion of one part of cement to four parts of the mixed sand and gravel, indicates that the mixture runs about 1:2¾:1¾, giving a weaker mortar and a smaller yield than the 1:2:4 combination. It would be cheaper, and better concrete could be obtained, if the amount of coarse material was increased and the fine decreased. Accurate proportions can only be brought about by the use of separate materials, of known size and gradation. The contractor will be repaid for the expense of screening by the greater yield per barrel of cement and the owner will secure a better, more uniform concrete.

Uniformity is impossible when bank-run gravel is used. There are many engineers who will question this statement, on the ground that it is always their practice to screen out a small sample, from which the amount of coarse material to be added is determined. The folly of this method of proportioning can be proved by screening samples from various parts of the same pit, which will show variations all the way from plastering sand alone to coarse gravel with no fine content whatever. No two wagon loads coming from the same pit will have the same proportions of sand to gravel —a strong argument for separation and remixing.

Good concrete, then, requires accurate proportioning of aggregate as well as accurate measurement of cement. To secure it two points should be strongly impressed on all who write specifications or are entrusted with their enforcement: First, that the proportions must be correctly stated and adhered to; second, that accurate measuring of the separated aggregates must be insisted upon.

Uniform Steam Boiler Law

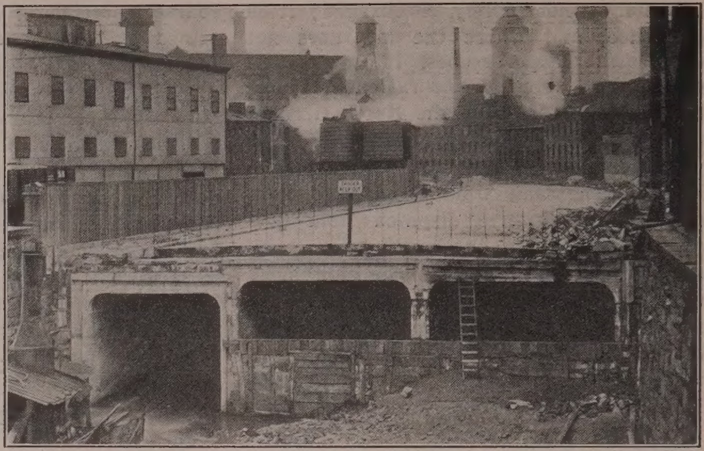
A long step forward has been taken by the Committee of the American Society of Mechanical Engineers to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for the Care of the Same in Service in the preparation of a preliminary report upon this important subject for discussion at the spring meeting of the Society at St. Paul-Minneapolis next month. The need of standardizing boiler practice as a whole throughout the United States and of making the laws relating to this branch of engineering uniform in the interests of safe and flexible service cannot easily be exaggerated. The committee has attempted to facilitate this responsible task by dealing practically with every essential phase of the subject, and the resulting report, when discussed by competent readers and amended if necessary for the sanction of the society, will constitute a classic document upon the generation of steam by safe methods.

Under present conditions, more stringent laws upon boiler practice are vitally needed in most of the states, but apart from the importance of securing safer local service stands the question of unifying legislation so that a boiler built in New York can be placed in service in Massachusetts as readily as a high-powered electric generator, or that inspection and operating methods approved in one commonwealth may apply equally well in another. In the report which is to be brought before the society, the committee has presented a complete working code covering the licensing of engineers and firemen, boiler inspection, rules for the construction and installation of boilers and other pressure vessels, rules for the operation and care of boilers, and various suggestions dealing with air pressure vessels, furnace and tube specifications, with tentative recommendations relating to furnace construction, housing, piping, fittings, discovery of defects, allowable temperatures on plates, and other matters of direct concern to the designer and builder, owner and operator.

The foundation of the report was the Massachusetts boiler laws, which have lately been adopted by the state of Ohio, the city of Detroit, and the city of Manila, P. I. Eight states, through legislative committees, or otherwise, have expressed interest in the report, and are only awaiting its adoption by the society to take up the subject. The Massachusetts laws are well known to be foremost in this class of legislation on this side of the Atlantic. In six years over 8300 boilers have been constructed under those laws and boiler explosions and derangements have been much reduced. The proposed rules, in general, are somewhat more stringent than those of Massachusetts. In connection with the question of safety legislation, it is suggestive to learn from the committee's memorandum accompanying the report that Germany has a set of rules even more drastic than the ones proposed. A good deal will be accomplished, however, if the final report of the committee is accepted as an initial standard, and the committee properly hopes to secure the ultimate adoption of the report by the Federal Government and by other Governments not now having boiler regulations.

The discussion of this monumental document at the Twin Cities is to be enriched by the critical and constructive comments of insurance, operating, manufacturing, educational and other authorities interested in boiler practice throughout the world, so that the approved report should represent the most advanced ideas upon the subject. It is nothing new to crystallize the best practice by committee reports to national engineering organizations; but seldom has an effort been made to bring together interests so diversified as in this case. The example may well be pondered by all professional societies. The document, which contains 238 closely printed pages, replete with statute forms, tables of data, drawings, formulæ and rules, satisfies the exacting demands of the most ardent advocate of thoroughness and attention to technical detail.

Bellmouth Intersecting 29-Foot Tunnel, Jones Falls



Three-Barrel Covered Conduit Inclosing Jones Falls

Baltimore's Public Improvements

Guide to City's Engineering Works for Members Attending Convention of American Society of Civil Engineers Next Week

By CALVIN W. HENDRICK
Chief Engineer, Baltimore Sewerage Commission

UP to the time of the great fire in 1904 Baltimore, the city selected for the annual convention of the American Society of Civil Engineers, which will begin next week, was probably the most conservative city in the United States. So well satisfied was the community with its condition that it paid scant attention to municipal improvements, such as sewerage, drainage, water, and paving. It was not until the great fire had wiped out practically the entire business section, with a loss of approximately $60,000,000, that the younger generation arose and took hold of the city's affairs in such an aggressive manner that I doubt if there is another city that has ever attempted to reconstruct itself on such an extensive scale as Baltimore is doing to-day.

REBUILDING BURNT DISTRICT

To rebuild the burnt district has involved an expenditure of approximately $75,000,000. The total new building operations since the fire amounts to about $154,000,000. The Burnt District Commission expended $7,425,000 in widening and paving streets. The dock department has spent in enlarging and reconstructing the dock system approximately $8,000,000. The water department is spending $5,000,000 in enlarging the water supply and installing a filtration plant. The fire department has installed a high-pressure fire service and pumping station at a cost of $1,000,000. The paving commission is spending $9,500,000 in an extensive program throughout the city, practically eliminating the cobblestones for which Baltimore has had such a reputation.

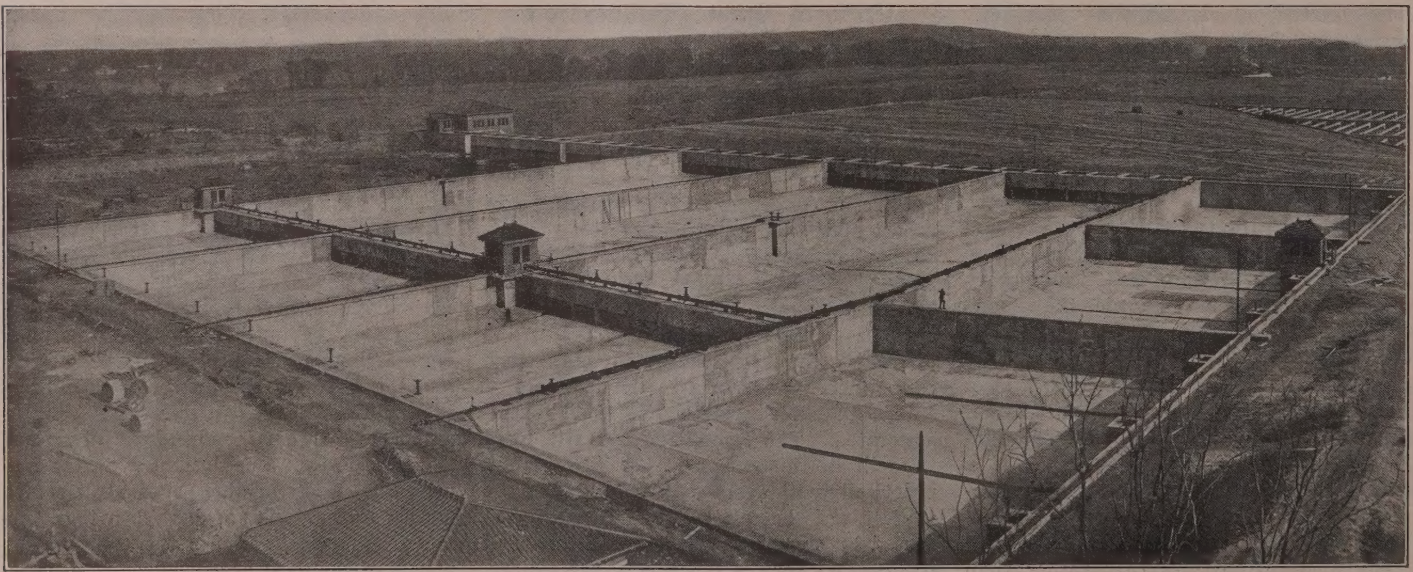
The annex commission is spending in extensive paving and street opening operations in the Annex District approximately $4,500,000. One of the most notable works is the new Key Highway, a broad street bordering the harbor and leading to Fort McHenry. This street and the Fallsway are being paved by the city engineer's department.

The construction of a 1000-ft. pier by the Canton Railroad Company, a private concern, shows the preparation that is going on in Baltimore to handle properly the increased traffic that will come to the city through the opening of the Panama Canal. Geographically, Baltimore is one of the best located ports in the United States, having three trunk-line railroads—the Baltimore & Ohio, the Pennsylvania, and the Western Maryland (or New York Central). It is near the great coal fields, its climate is mild, and excellent manufacturing sites with rail and water connections are available.

SEWERAGE AND DRAINAGE

The sewerage and drainage of the city had probably fallen farther behind than any other public work. It was in a deplorable condition. The population reached nearly 600,000 without a sewerage system, and depended on the crude method of disposing of the sewage by means of cesspools and private sewers. This practice had become such a menace that the Legislature passed most stringent laws, requiring the installation of a sewerage system and bringing the sewage to a very high degree of purity before being discharged into the Chesapeake Bay or its tributaries (the oyster industry of the Chesapeake being a great factor in Baltimore business life). A sewerage commission was appointed to handle the matter, as the problem was of such magnitude.

The system of sewers and drains, together with the disposal plant, will cost about $21,500,000, and will be completed in 1916. The city has gained by not having installed the sewerage system as other cities have done, in piecemeal, covering a long period. The system has been planned

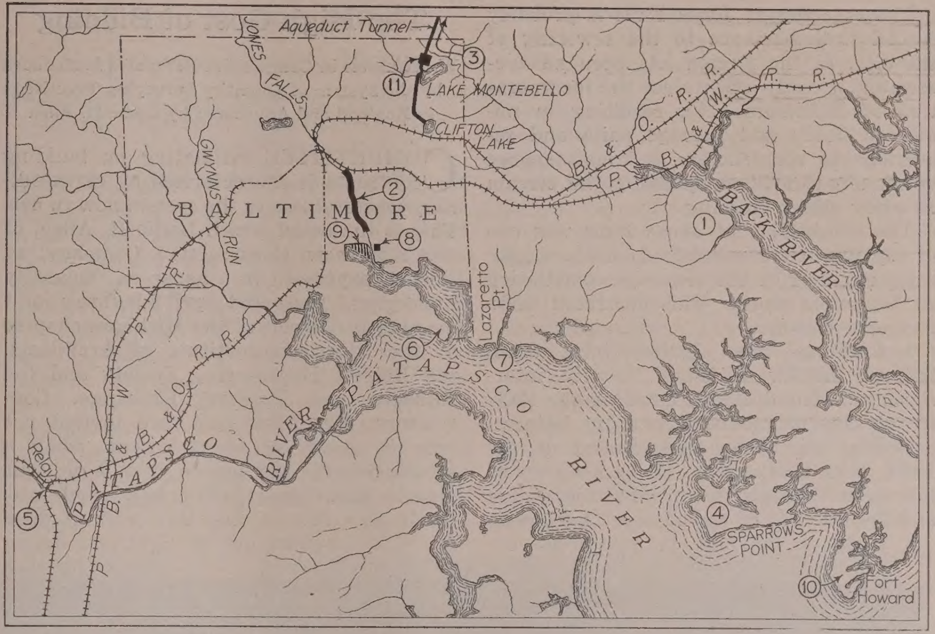


View of Back River Sewage-Treatment Works, Showing Sludge and Settling Tanks and Filters in Distance and constructed according to the most modern methods, thereby bringing the city from one of the lowest on the list in sanitary matters to the very top. Baltimore will soon have the most modern, up-to-date system in the world.

The extensiveness of the system, together with its modern plant, has made Baltimore the Mecca for engineers from all parts of the world. The visiting list shows engineers and delegations from England, Germany, France, Canada, Mexico, South America, Japan, Sweden, Australia, and all parts of the United States, and a great volume of correspondence has been received asking for reports, data, etc.

The work has involved a great many difficulties because it was necessary to construct two systems of sewers and drains, crossing and recrossing each other in thousands of places in the beds of streets and alleys congested with a hundred years' accumulation of pipes, private sewers, etc., with no space left for the new sewers and drains.

The existence of thousands of private sewers built by owners of buildings had complicated the matter greatly. In one block there were as many as twelve private sewers. Maintenance of these sewers until the new sewers are ready to receive the sewage and pass it to Back River for purification has been difficult. The law does not permit the intercepting and discharge of this sewage until we are ready to treat it. There are numerous old buildings on shallow foundations, in some cases church towers with foundations only 18 in. deep and within 25 ft. of a sewer trench 35 ft. deep. Heavy grades, with low, flat sections, and work below tide, have further complicated the work.



Points of Engineering Interest in Baltimore and How to Reach Them

1. *Sewage-Disposal Plant at Back River.*—Reached by Back and Middle River electric-car lines, running every twenty minutes from Baltimore and Holliday Streets; about forty-five-minute ride.
2. *Jones Falls Conduits and Viaduct.*—About five-minute walk from Hotel Belvedere.
3. *Loch Raven Dam.*—Reached by automobile or by the Maryland & Pennsylvania Railroad; about ¾ mile from Loch Raven Station.
4. *Sparrows Point Steel Plant.*—Reached by trolley, starting from Howard and Franklin Streets; about forty-five-minute ride.
5. *Stone Viaduct of Baltimore & Ohio Railroad at Relay.*—Reached by train from Camden Station; about twenty-minute ride. This viaduct was started in 1835 and completed about ten years later. It is the first stone railroad bridge built in the United States and is still in service, carrying modern rolling stock.
6. *Fort McHenry.*—Reached by trolley; about three-quarters of an hour ride from Hotel Belvedere.
7. *New 1000-Foot Pier.*—Now under construction for Pennsylvania Railroad.
8. *Sewage Pumping Station.*—Reached by trolley; about twenty-minute ride from Hotel Belvedere. This station, at East Falls Avenue and President Street, contains three vertical, triple-expansion sewage pumps, each having a capacity of 27,500,000 gal. daily, against a total head of 72 ft. Provision is made for the installation of two additional pumps in the future. The total cost of land, buildings and materials is approximately $1,000,000.
9. *Municipal Docks on the North Side of the Harbor.*—About twenty-minute ride from Belvedere Hotel by electric line. Six piers have been completed.
10. *Fort Howard.*—Reached by trolley, starting from Howard and Franklin Streets; time required, one hour.
11. *Mechanical Filtration Plant.*—This plant is now under construction. About thirty-minute ride from Hotel Belvedere via Harford Avenue Line; ½-mile walk from car line.

SEWAGE-PUMPING STATION

Since the Legislature required the purifying of all sewage before discharging it into the Chesapeake Bay or its tributaries, it was highly important to reduce the amount of liquid to be treated to a minimum. It was, therefore, decided to construct a system of sanitary sewers, the storm water being carried off to Jones Falls and the Basin by separate storm-water drains. By a series of intercepting sewers two-thirds of the city's sewage is carried to Back River by gravity. The other third is intercepted along the river and harbor front, carried to the pumping station in the central part of the city, and there lifted by pumps a height of 72 ft., including friction, through 48-in. iron force mains a distance of about a mile, from which point it flows by gravity to the disposal plant.

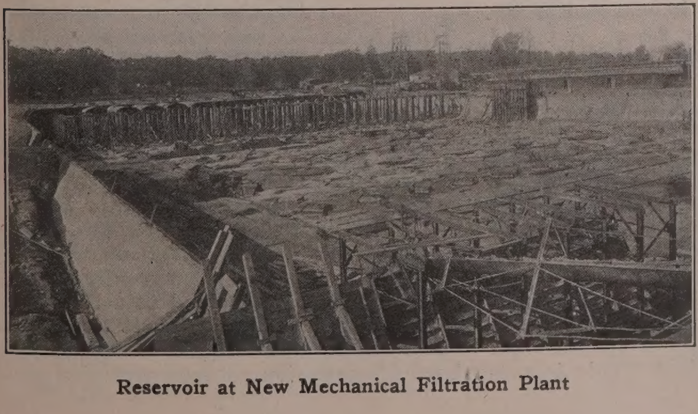
The disposal plant is located 5¾ miles east of the city. The purified sewage, before being finally discharged into Back River, an estuary of the Chesapeake Bay, 14 miles from its entrance into the bay, is conducted to a hydroelectric plant, where it operates turbines which in turn run dynamos, producing sufficient electric power to light and run the plant. Three of the 27,500,000-gal. pumps are completed and in operation at the pumping station.

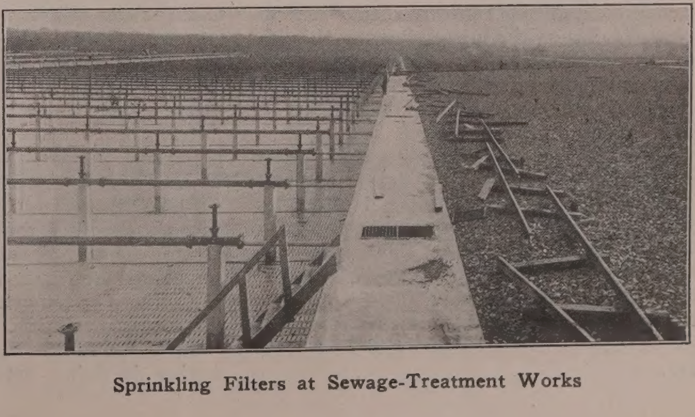
At the disposal plant 18 acres of sprinkling filters, with three hydrolytic tanks and three sludge-digesting tanks, are completed, and a contract for twenty-eight Imhoff tanks, to take care of a population of 112,000, is under construction. On the completion of these Imhoff tanks the plant will have a capacity of treating the sewage from a population of 600,000. These Imhoff tanks are an extension of the system. We thought it desirable to make this extension along Imhoff-tank lines in order to determine what advantages, as to cost of construction and handling the sludge, could be secured by Imhoff tanks on a large scale.

Between 500 and 600 miles of sewers and drains have been completed, varying in size from 5 in. to 29 ft. in diameter.

JONES FALLS IMPROVEMENT

A most interesting hydraulic problem was encountered in the drainage work of the city in changing the route of Jones Falls by a diversion tunnel under Guilford Avenue and inclosing the Falls in reinforced-concrete conduits from Chase Street to a point south of Baltimore Street. The tunnel is 28 x 29 ft. and the three conduits vary in size, on account of the grade, being 20 x 20 x 15 ft. each at Baltimore Street, at which point the drainage problem is solved by tide level.


Reservoir at New Mechanical Filtration Plant


Sprinkling Filters at Sewage-Treatment Works

The covering of Jones Falls is probably second in importance to the sewering of the city, as the stream has been an eyesore and a costly affair since the incorporation of Baltimore City, resulting in numerous floods and damage suits and requiring the construction and maintenance of numerous bridges spanning the stream at every street crossing.

The elimination of Jones Falls was one of the first recommendations made by the chief engineer of the sewerage commission on beginning work. This embraced three recommendations:

1. Building an intercepting drain through the low section of the city, intercepting all the drainage entering the Falls in this low district and carrying it to an outlet in the harbor independent of the Falls, thus eliminating the backing up of the water through these connecting drains and the flooding of the adjacent low areas.

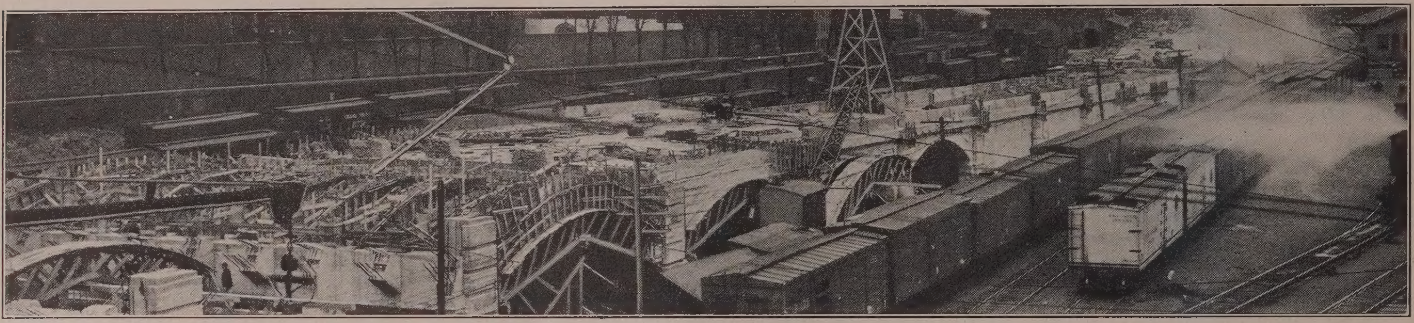
2. Inclosing the falls in reinforced-concrete conduits, eliminating the overflowing of the banks and the bridges spanning the stream at each street crossing, and redeeming a strip of land 75 ft. wide through the heart of the city from Baltimore to Biddle Streets.

3. Constructing a roadway on top of these conduits by laying Belgian blocks, and carrying the roadway from the low to the high section of the city over the Northern Central Railway tracks by a viaduct.

All of these recommendations are drawing to completion, and by the latter part of the summer the falls will have been completely eliminated and a new highway created, giving to the city a much-needed new north-and-south street on easy grades.

An interesting feature of this construction is that the falls have been inclosed, the bridges eliminated, and the land redeemed for a street at a cost of $1,400,000, or $600,000 less than was spent in constructing the old retaining walls bordering the Falls, which did not eliminate the flooding or the bridges, nor redeem the land. This shows that the method of handling engineering problems has made vast strides by the use of concrete and steel reinforcement. The increased taxes on the property along this improvement will be sufficient to pay the interest on the bonds and create a sinking fund that will eventually wipe out the cost of making the improvement.

Other points of engineering interest in Baltimore, as indicated on the accompanying map, are: The Lock Raven dam and the new mechanical filter plant at Lake Montebello, Sparrows Point steel plant, stone viaduct of the Baltimore & Ohio Railroad at Relay, Fort McHenry, new 1000-ft. piers for Pennsylvania Railroad, municipal docks on the north side of the harbor, and Fort Howard.



Reinforced-Concrete Viaduct Raising Street Grade to Present Elevation of Eager Street, Baltimore

The High Cost of Bidding

Wastefulness in Competitive Estimates Is Reduced by the System of Quantity Surveying Practised in England and Advocated by Leslie H. Allen

COMPETITIVE estimating on building contracts is characterized by extraordinary wastefulness in the system now in use. This is the belief which Leslie H. Allen, of the Aberthaw Construction Company, of Boston, expressed in a paper on "Quantity Surveying," presented April 8 before a joint meeting in Detroit of the Michigan chapter of the American Institute of Architects, the Detroit Engineering Society and the Builders and Traders' Exchange. Contractors, Mr. Allen said, are invited not only to guess or calculate how much a structure will cost before it is built, but also to guess or calculate how much material goes into it, and this work is done not by one builder but by eight or a dozen. The labor of all but one is absolutely wasted. It is hard to impress upon the architect or the building owner that this waste is unnecessary or can be eliminated by the quantity system in which bills of quantities are furnished free with the drawings and specifications to all competing bidders.

The quantity surveyor should be a man who makes it his sole business to take off quantities. He should receive the plans from the architect and compute from them the quantities of material and labor for the building.

Proper Fees

If he is paid a proper fee for his work he is able to have all his figures carefully checked. Contractors cannot give their whole time to estimating, and they have to work so quickly that there is no time for any but the most superficial checking of the quantities, except by the square-foot or cube-foot price of the building—a very unreliable method.

The quantity surveyor should take off the whole job and not confine himself to those trades which will be executed by the general contractor's own force. A bill of quantities should contain separate schedules for mason work, structural steel, earth work, concrete, structural carpenter work, finished carpentry, hardware, plastering, plumbing, painting, ornamental iron work, and so on. It is the aim of the quantity surveyor to take off and describe the items in just the way that will be of the most service to the contractor. This is a very important matter and on it largely depends the success of the quantity-surveying movement.

In Milwaukee a bureau of quantity surveying is being organized. This is subscribed to by the chief contracting firms in the local builders' exchange. The organization will be made up of the chief estimators in the city, who will receive fixed salaries for their work. Every member of the exchange will subscribe a sustaining subscription to the bureau and in addition will pay a small fee for the use of each bill of quantities. He will also add to the amount of each bid he makes on quantities furnished by the bureau a percentage, varying from 1 to 2 per cent for these quantities, and if he is successful in getting the job he will pay this fee to the bureau unless the owner pays it direct. At the end of the year any surplus will be divided among the contributing builders.

English Practice

It is not easy to set a fee for the services of a quantity surveyor that will apply in every case. In England the maximum fee is usually a percentage of the lowest bid and ranges from 2½ per cent on dwelling houses, churches, and other work which contain a very large amount of detail, down to as low as 1 per cent on large plain, simple factory and warehouse work. Although at first sight this fee of 1 per cent on a $100,000 factory will look large, yet the cost of an estimate on such a factory at the present day is more than this; but the cost is spread around among the community instead of being concentrated in one payment to one party. The only estimating expense incurred by the builder under the quantity system will be the time spent on pricing the estimate, visiting the site and making inquiries from material men. This will take very much less time than any attempt to scale the quantities, so that the contractor's expense of estimating will be practically negligible. It is very important that proper fees should be charged from the start. If fees too low to pay for painstaking, accurate work are established, the work will not be done carefully. It will be extremely difficult to raise them, and the system and the whole movement will suffer.

Extra Work

One feature of the quantity system as used in England would be looked upon with mixed feeling by contractors here, although welcomed by architects, and that is the settlement of extras. It does not follow that because a bill of quantities has been made the basis for estimate that it must therefore be used as a basis for settlement of extras, unless it is so provided in the contract. A contractor may base his bid upon quantities and may refuse to sign a contract that called for them to be used as a basis for extras. But if he does so agree to use the quantities as a basis of extras, one great bone of contention between architects and builders is removed and better relations are at once established. There is no more thorny and difficult subject that comes between architect, owner and builder than the value of extra work. The quantity system provides a method for the measurement and valuation of most items of extra work or omitted work, for if the contractor puts the unit price of each item in his bill of quantities a definite basis is laid down for the valuing of extras.

One of the greatest difficulties ahead of the establishment of quantity surveying is the subject of standardization of measurements. It is an unfortunate fact that in no trade is there any agreement between contractors as to how any items should be measured. Take, for instance, doors and windows. There is no method whatever of measuring a door or door frame or trim that is universally used. Most carpenters will look at the plan of an opening and say, "Yes, that will cost you $20 an opening," or $30 or $15 as the case may be. When we come to brickwork, some masons measure the net cubical content of the brick, others will measure all corners double, others will not deduct openings, some will deduct half openings, and some will not deduct stone work where stone work is embedded in brick and others will.

Standards of Measurement

In drawing up a standard of measurement, two guiding principles should govern, although these may conflict with existing practice in many cases. The first rule is this, that all work should be measured net as fixed in the building, no allowance being made in the measurements for waste. The second rule is that material should in no case be measured to pay for extra labor. If a plumber is measuring a hundred feet of 1-in. pipe in which there are ten elbows and three tees, it is wrong in principle for him to count each one of the elbows as 2 ft. of pipe.

The subject of the standardization of measurements will be a very important step toward the establishment of a proper system, and whether a quantity system is ever established or not, there is an urgent need for a proper understanding of the methods of measurement of work in the building and engineering work. This would be a very useful field for the activities of some of our national associations of engineers, contractors and sub-contractors.

Test of Wire-Cut and Repressed Paving Brick

Performances of Small Slabs Used in New York Highway Department Experiment Favorable to First Type

EXPERIMENTS to compare the penetration of grout for repressed paving brick with horizontal grooves in the end faces, and for wire-cut brick with double-beveled or bulged ends, recently made in the New York State Highway Department, not only showed that the penetrations were equally satisfactory but proved that the wire-cut samples formed a stronger bond with the grout. The tests were inspired by the protests of an Ohio company, which, after beginning shipments of the improved wire-cut blocks for a State contract was told that horizontal-grooved ends were required.

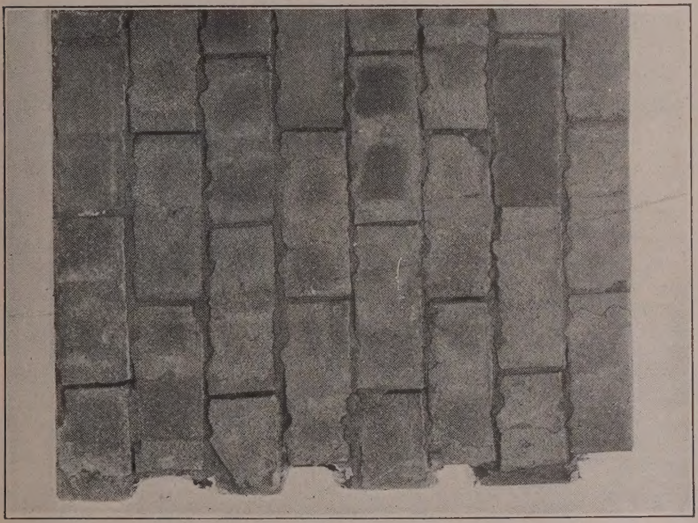


Fig. 1—Part of Bottom Face of Wire-Cut Brick Slab

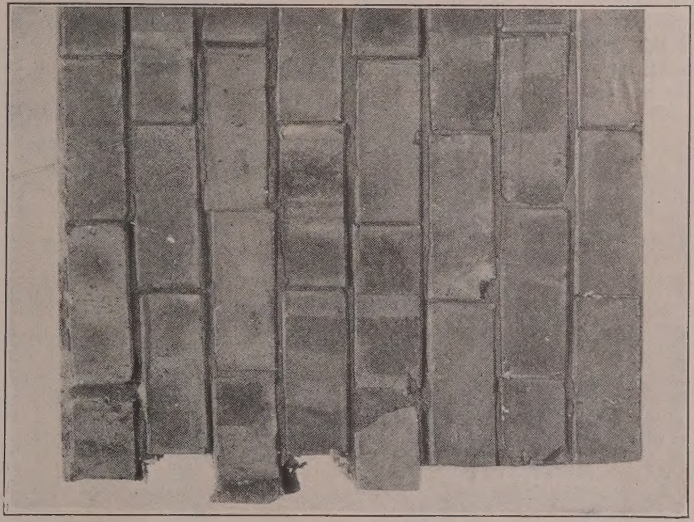


Fig. 2—Part of Bottom Face of Repressed-Brick Slab

Under the direction of William C. Acheson, division engineer of highways at Buffalo, two boxes were made 2½ x 4½ ft. in dimensions, and two slabs were built on a cushion of sand. Five days after these were grouted the boxes were inverted, the bottoms taken off and the sand cushions removed.

In both cases, as Figs. 1 and 2 show, the grout had penetrated to the bottom and filled all the crevices. The slabs were then broken transversely to discover how uniform the penetration was. The important feature observed in this process, however, was that while only one blow of the chisel and hammer was necessary to divide the repressed brick slab, it was necessary to drive the chisel into five different places before the wire-cut slab would separate. It was apparent to Mr. Acheson that this superior bond was to be credited to the rough surfaces of the wire-cut brick, as compared with the smooth faces of the stamped product. This distinction is strikingly shown in Figs. 3 and 4. The broken sections of the slabs were placed one above the other for the purposes of the photograph. Mr. Acheson's report states that the bulged-end joint was stronger than that furnished by the grooved ends, as shown by the fact that the repressed-brick section could not be lifted from the floor without weakening at the end joints. The arrow in Fig. 4 indicates where one fracture occurred. Mr. Acheson plainly stated that this fracture shows that the double-beveled end gives the superior joint, due to its roughness, and, because of this superior bond at both ends and sides, he recommended that the wire-cut product be admitted to use on the roads, insofar as the test made justifies.

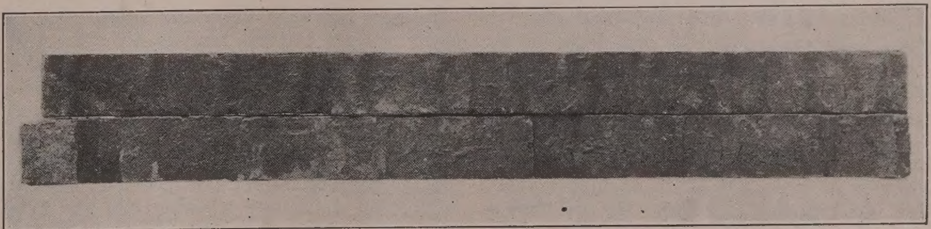


Fig. 3—Mortar Adhering to Joint of Wire-Cut Brick Slab

One section is set on the other to show entire cleavage plane

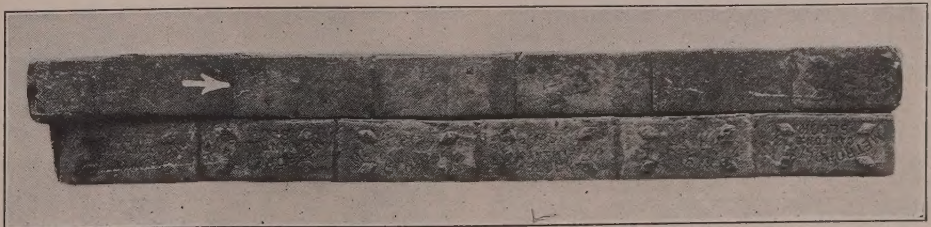


Fig. 4—Broken Repressed-Brick Slab, Showing Poor Adhesion of Mortar

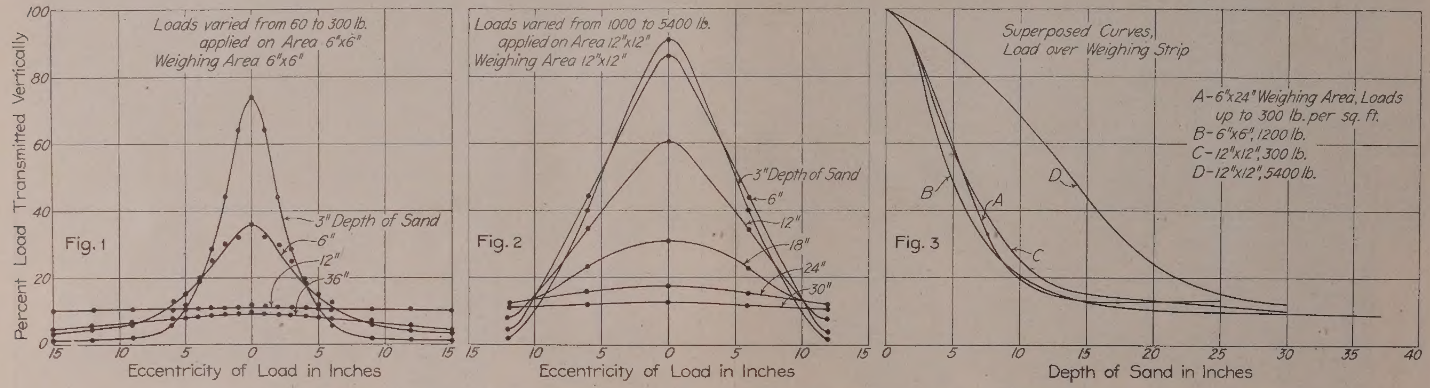
Arrow marks end joint which broke in handling

Distribution of Vertical Soil Pressures

Dry-Sand Tests Recently Completed at the Engineering Experiment Station of the Pennsylvania State College

By J. A. MOYER
Acting Director

VERY little experimental work has been done bearing on vertical pressures transmitted from external loads through various depths of soil, and practically none at all on the distribution of these pressures. It may be said, therefore, that a series of tests which is being conducted in the engineering experiment station of the Pennsylvania State College constitutes a pioneer effort in this practical field. Some of the tests, involving sand only, have been completed and form the subject matter of this article. They were conducted by Roy B. Fehr and C. R. Thomas, under the general supervision and with the constant encouragement of Willis Whited, bridge engineer of the Pennsylvania State highway department. Complete data, curves and results will be published as Bulletin 8 by the experiment station.



Curves Showing Per Cent of Load Transmitted at Various Distances from the Center for Different Depths of Sand

Clean, dry river sand, of medium sharpness—a typical brown building sand—was used in the first experiments. A dry sand is more homogeneous, more uniform in its properties, and therefore more likely to give concordant results. Furthermore, as sand gives the minimum arching effect, the loads transmitted will represent the maximum or worst possible condition of loading, and consequently data used for sand will be on the safe side for all other soils.

The original apparatus consisted of a box about 8 ft. square and $1\frac{1}{2}$ ft. deep, raised about 3 ft. off the floor. A hole 24 x 36 in. was cut in the center of the bottom. Some preliminary experiments were run, using a system of slats, levers and spring balances on the weighing device. The results, however, were not at all in harmony, probably due to the fact that the movement of the weighing levers was too great, thereby causing a movement of the sand grains and consequently a redistribution of the pressure. It was evident that in order to obtain reasonably accurate results the *movement* of the weighing strip should be made much smaller.

WEIGHING WITH PLATFORM SCALE

An apparatus which was found to give admirable results was developed by cutting an opening in the bottom of the box for the weighing strip, which was supported wholly and directly by the platform of a small 300-lb. platform scale. The scale ratio was 50 to 1, and as the movement of the arm was restricted to 1/16 in., the maximum movement of the platform and therefore of the weighing strip was $1/50 \times 1/16 = 1/800$ in. Surrounding this opening and resting on the floor of the larger box was a bottomless box, 3 x 4 x 4 ft. deep. This arrangement afforded constant conditions of restriction of the sand under test. A piece of cloth was spread lightly over the weighing strip to prevent the sand from running through. The sand was struck off to a certain depth and a known weight of bricks was piled on a loading strip, which in these tests was always of the same size as the weighing strip.

Since there was only one weighing strip, the distribution of pressure had to be obtained by varying the position of the load. The scale was read before and after the loads were applied. The difference between the two readings gave the amount of pressure transmitted through the sand. One hundred times this difference, divided by the known weight of the load gave the percentage of the load transmitted vertically through the sand.

The loads ranged from 60 to 300 lb. per square foot, placed at intervals from a position directly over the weighing strip to one 15 in. off center. By moving to the right and left a double set of observations was obtained for each depth of sand. Fig. 1 gives results of tests made with a 6 x 6-in. weighing strip and a loading strip of equal size. Similar tests were also made with 6 x 24-in. and 12 x 12-in. strips. Readings were taken for five different values of the load between 60 and 300 lb. per square foot in the cases of the 6 x 24-in. and 12 x 12-in. weighing strips and between 240 and 1200 lb. per square foot in the case of the 6 x 6-in. weighing strip. The calculated percentages of transmission for each of these groups of observations lie for the most part well within 10 per cent of the mean value. Furthermore, there are practically as many of the results below the average as above. Hence these averages may be regarded as representative values of transmission for any of the pressures employed in these tests.

Fig. 1 shows how the vertical component of pressure due to the concentrated load is distributed. The points plotted are averages for all the results in percentages of the loads transmitted, as obtained for given depths of sand and given eccentricities of load, either right or left. A study of these curves reveals a sudden bend for depths of sand less than 12 in. at the approximate point where the eccentricity is equal to the width of the loading strip. In other words, this sharp bend seemed to occur in every case when the loading strip was no longer over any part of the weighing strip. Beyond this part of the curve the per cent transmission was less than 16.

Every test made with this apparatus gave results which appeared to be consistent and which could be duplicated in subsequent tests. The small fluctuations that occurred were such as might reasonably be expected in such work. In fact, the success of this small platform scale apparatus seemed so assured that it was decided to build a larger apparatus having a capacity of 6 tons.

TESTS WITH SIX-TON APPARATUS

The principal change in the larger apparatus, which is shown in the accompanying illustration, lies in the application of the load by means of a calibrated hydraulic jack instead of a known load of bricks. The jack is blocked up so that it works against the overhead I-beam. The platform scale is a Fairbanks "Standard" having a weighing capacity of 4000 lb. and a scale ratio of 200 to 1. Since the motion of the beam was restricted to $\frac{1}{8}$ in., the maximum movement of the platform, and therefore of the weighing strip, was only $\frac{1}{8} \times 1/200 = 1/1600$ in.

The method of procedure was similar to that of the former tests. Great care was exercised in preventing the jack from getting out of plumb, so as to make sure that the loading strip would sink evenly into the sand. A series of tests was run under the same conditions as the tests shown in Fig. 1 in order to find out whether larger loads would make any difference in the percentage of transmission. The depth of sand was varied from 3 in. to 30 in., and the eccentricity from 12 in. on the right to 12 in. on the left. The loads were varied from about 300 lb. to 5400 lb. on a 12 x 12-in. loading strip. Figs. 2 and 3 show the results.

The superposed curves of Fig. 3 show the relation between the pressure transmitted vertically for loads up to 5400 lb. per square foot and the depth of sand when the load is applied directly over the weighing strip.

CONCLUSIONS

The following points should be noted for the heavier loads: The 12 x 12-in. loading strip began to sink in the sand at loads of approximately 2500 lb. where the sand exceeded 12 in. in depth. For depths smaller than this the sinking did not become pronounced until a much higher load was reached.

At each increment of load after sinking began additional sinking occurred. Readings, however, were not taken until the block became stationary under the applied load.

A distinct heaving and flowing of the sand occurred for some distance on each side of the loading strip. The sand usually assumed a water-ripple formation surrounding the block. As many as three ripples ½ in. high occurred.

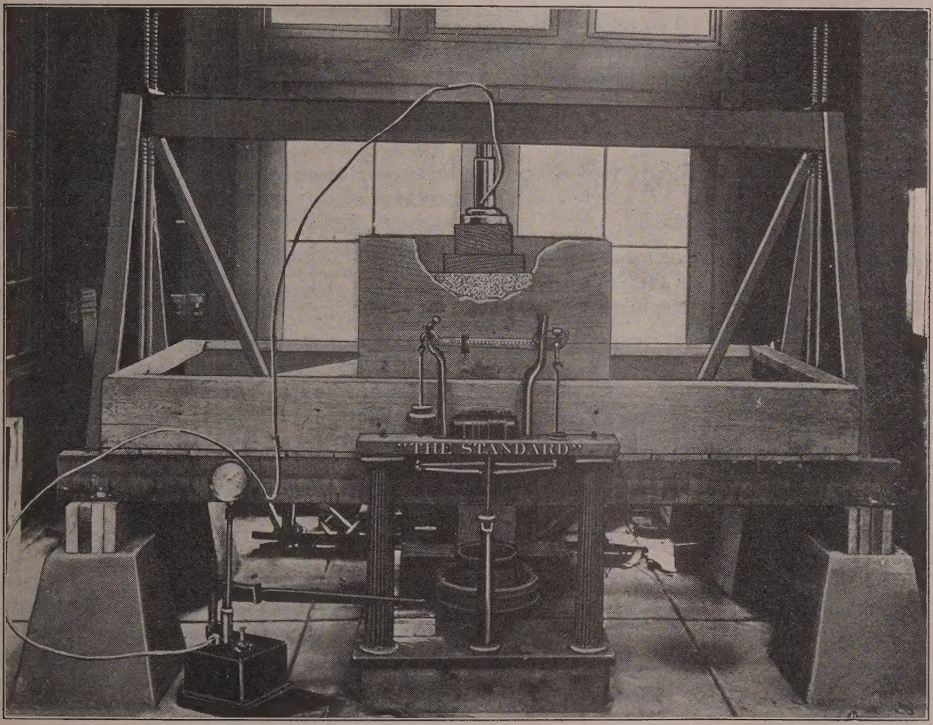
In every case the percentage of transmission appeared to show a uniform increase as greater loads were applied. It is possible that this may be due to the flowing of the sand as well as to the slight decrease in depth due to the embedding of the loading strip.

A noticeable decrease in the per cent of load transmitted occurred when the eccentricity of the loading strip equalled its width. This became less marked as greater depths of sand were reached, as indicated by the flattening of the distribution curves in Fig. 2.

The results of the tests so far conducted suggest two general statements. At depths of 12 in. for loads up to 300 lb. per square foot and 23 in. for loads up to 5400 lb. per square foot the per cent of transmission appeared to have a maximum value of 20. Tests in 6 x 6-in. strips reached 1200 lb. per square foot with the same results.

The other statement suggested is that the point at which a marked change occurred in the per cent of transmission due to eccentricity was at a distance from the center equal to the width of the weighing strip, and at this point the maximum transmission was 16 per cent. For greater eccentricities this value was never exceeded.

After obtaining sufficient data on sand it is the intention to investigate similarly other soils, such as gravel, loam and clay, with various percentages of moisture. It is believed that the resulting data will be of great service to the engineer who has to design culverts and arches.



Platform-Scale Apparatus Used in Tests at Pennsylvania State College

Compressed-Air Work Specifications

Comprehensive Requirements Governing Use of Compressed Air in Construction of New York Subway Tunnels under East River

THE construction of the East River tunnels from Whitehall Street and from Old Slip, New York, to Brooklyn, which are officially known as contract sections 2 and 3 of routes 33 and 48 respectively, involves about 9800 lin. ft. of double lines of single-track tunnel excavation under compressed air, most of it being shield work with cast-iron lining. A large portion of the excavation is in sand at a maximum depth of nearly 90 ft. below mean high water. The specifications governing the work are very comprehensive and explicit; that portion referring to the compressed-air operations was especially prepared by Frederick C. Noble, division engineer.

Among the important features of these specifications are the requirements for power units, a positive excess capacity over estimated requirements, a minimum air supply for headings, dependent on the number of headings supplied from one plant; provision for detailed records of operations, facilities for making experimental researches, sanitary and medical equipment, and important safety provisions, including the maintenance for each heading of two air chambers, an emergency lock, a safety screen and a prescribed quality of air, all of which are here described.

PLANT AND CAPACITY

The contractor must install air compression, hydraulic and electrical machinery, hoists, pumps and all other necessary apparatus of the highest grade in use for the work to be performed and having a capacity sufficient to meet not only unusual conditions but emergencies, and to afford a margin for repairs at all times. Provision must be made for storing in tanks at the boiler house enough feed water for twelve hours' supply, unless connections can be made with two independent and separately sufficient sources of supply. If electricity is used for operating compressors supplying air to the tunnel headings, the supply cables shall be in separate lines and shall each connect, if possible, with two independent and separately sufficient sources of current.

The compressors shall be capable of furnishing simultaneously to each heading an air supply sufficient in volume and pressure to enable work to be done as nearly as possible in the dry, and to afford the specified degree of ventilation. At each heading where the shield is used the air supply pressure of 45 lb. per square inch above atmospheric pressure must equal at least 10,000 cu. ft. of free air per minute as measured by piston displacement, unless both tunnels are operated from the same compressor plant, when this air supply may be reduced to 8000 cu. ft. of free air per minute. The plant, in addition, must be capable of furnishing to all parts of the work a sufficient air supply at a pressure of 100 lb. or more if required for operating drills, grouting machinery and other pneumatic tools. The air for the compressors shall be drawn from pure outside sources and protected from fouling by lubricating oil.

The compressor revolutions shall be registered by mechanical counters, and the pressure in the air receiver shall be continuously registered. Cooling apparatus shall be provided to maintain the temperature of the air in the tunnels and caissons always at a moderate degree. All buildings for the compressor plant and in the immediate vicinity shall be as nearly as practicable fireproof and all reasonable precautions shall be taken to prevent and extinguish fires. A water line shall be extended into each heading, 200 ft. of hose, and nozzle connections shall be maintained ready for constant use at each bulkhead and no lighted candles or matches will be allowed near roof timbering in compressed air.

MEDICAL AND SANITARY RULES

The workmen's quarters shall be well lighted, heated and adequately provided with running hot and cold water, showers, lockers and facilities for resting, for drying clothing, and for providing hot coffee. Care shall be taken to keep all parts of the tunnel in a thoroughly sanitary condition and free from refuse or decaying matter. There shall always be on duty a competent physician and surgeon experienced in the treatment of the physiological effects of compressed air, and he shall care for the health of the employees and supply treatment and medicines to them whenever needed.

There shall be maintained in close proximity to the shaft at each side of the river a completely equipped hospital room with an attendant constantly in charge. Each hospital room shall include in its equipment a commodious hospital lock in two compartments, where men can be subjected to the regular working pressure if attacked by caisson disease. Such locks shall contain cots, a telephone, air gage, and arrangements for ventilating and heating. Provisions shall be made for the immediate removal and hospital treatment of any employee who may be injured or become ill. No person shall be employed in compressed air until after passing a satisfactory medical examination, and any employee absent for ten or more successive days shall be reexamined before being permitted to resume work in compressed air.

All reasonable facilities shall be afforded for the investigation of the physiological effect of compressed air, including the conduct of experiments and the collection of records in connection therewith, to be undertaken by such scientific bodies of individuals as may be designated for the purpose by the commission.

AIR CHAMBERS

Air chambers shall be formed in the tunnels by brick, concrete or steel plate bulkheads of sufficient strength to safely resist a pressure of 15 lb. per square inch. Whenever the air pressure in the heading exceeds 22 lb. per square inch above atmospheric pressure, two air chambers shall always be in use, except when headings are being started from shafts, and the pressure in the outer one shall not exceed one-half the pressure in the heading. The distance from the heading to the nearest bulkhead shall not exceed 800 ft. during the progress of the work.

Three metal airlocks are to be firmly set and anchored in each bulkhead. These shall consist of two main locks not less than 6 ft. in diameter, heated and ventilated if required, and an emergency lock not less than 5 ft. in diameter, which shall be located as high up from the bulkhead as practicable and shall be large enough to hold an entire heading shift. When not occupied the emergency lock shall be kept open toward the heading and ready for instant use at all times. Lock doors must operate easily. A heavy glass bull's-eye must be set in each end of each lock.

Air valves must be arranged to be controlled from inside the lock. One of the main locks shall be connected to the main air line so that it may be locked from outside. Each lock shall be provided with an air gage and a clock. An 8½-in. air gage shall be placed in an accessible position on the outer side of each bulkhead. A recording air gage shall be placed on each main and shall be locked and the key kept by the engineer. A lock tender shall be on duty at all times at each lock bulkhead. A watchman shall be on duty at all times in the heading and when for any reason the work is suspended.

SAFETY SCREEN

In each heading chamber, when the same extends beyond the river bulkhead line, there shall be provided a safety screen extending from the springing line of the tube to the track. It shall be made of substantially braced steel plates with airtight joints. It shall be moved forward as the work progresses so as never to be more than 115 ft. in the rear of the shield. In each heading chamber, when the same extends beyond the bulkhead line, the contractor shall provide about the middle of the height of the tunnel a substantial runway, at least 3 ft. wide, leading from the shield platform to a platform at the emergency lock. The runway shall be provided with a handrail and steps or ladders at frequent intervals for access from the track level. A telephone connection shall be maintained in service from each heading and each lock to the power house and to the office of the commission's engineer corps near the shaft.

The air supply through the shaft and tunnel in each heading shall be through two pipes, each at least 10 in. in diameter, with sufficient capacity to prevent excessive drop in pressure in regular working. Each supply pipe shall be provided with a pressure-regulating valve in each air chamber and with suitable valves arranged for by-passing at a convenient point between the power house and the shaft. Special devices shall be used to deaden the noise of air supplied or exhausted.

The supply of fresh air shall be sufficient to permit work without danger or discomfort, and where work is in compressed air such supply shall be sufficient at all times and places to prevent the accumulation of carbon dioxide to a greater amount than one part in one thousand by volume. A foul-air vent pipe 6 in. in diameter shall be carried back from each heading under pressure to the ordinary atmosphere and shall be provided with a suitable regulating valve so placed as not to be readily tampered with. The compressors must be so run as to maintain at all times a change of air through the regulating valves. Special means must be provided for the rapid removal of blasting fumes.

International Engineering Congress

Announcement of Subjects of Papers to Be Presented in San Francisco in 1915 on Materials of Engineering Construction

AMONG the general subjects to be treated before the International Engineering Congress, which will be held in San Francisco Sept. 20 to 25, 1915, probably the one having the broadest interest is that of materials of engineering construction, which enters into all phases of engineering activity. The list of topics which will be treated in this section is as follows:

Timber, preservative treatment of timber, substitutes for timber in engineering construction, brick in engineering structures, clay products in engineering structures, probable and presumptive life of concrete structures made from modern cements, aggregates for concrete, slag cement, waterproof concrete, cements containing additions of finely ground foreign material, economics of the world's supply of iron, life of iron and steel structures, employment of special steel in engineering construction, the place of copper in the present engineering field, and the economics of the world's supply thereof, alloys and their use in engineering construction, aluminum in engineering construction, influence of the testing of materials upon advances in the designing of engineering structures and machines, cement testing, testing of metals, testing full-sized members, proof testing of structures.

The papers to be presented from the United States have already been arranged for from the recognized leading authorities on the various topics. Arrangements for the papers from foreign authors are being rapidly concluded, and the aggregation of papers which will be presented will constitute a broad review of the field and be of the highest value.

Full information concerning the congress, the price of subscription, and the arrangement for purchase of volumes of the proceedings may be obtained by addressing the Committee of Management, International Engineering Congress, Foxcroft Building, San Francisco, Cal.

Proposed Building-Height Restriction in Minneapolis

Ordinance Would Limit Maximum Height to 140 Feet and Preserve 60-Degree Light Angle for Lowest Stories

BUILDING-HEIGHT restriction has been under discussion in Minneapolis for some time, the chief advocate of restriction being the Minneapolis Civic and Commerce Association. As a result of its studies it has framed the ordinance printed below and has prepared a convincing booklet embodying the reasons for advocating restriction. Much opposition is being met, despite the array of data which the association has placed before the citizens. The ordinance proposed is as follows:

1. A building shall not be erected or subsequently increased to a height greater than one and three-quarter times the width of the street, with a maximum height of 140 ft. to the top of the parapet, except as hereinafter provided.

2. In addition to the above, not more than two stories not exceeding 12 ft. each in height above this height, providing that such stories be so constructed that all projections of cornices, etc., will not lessen the angle of light given by a 60-deg. angle, projected from a point 60 ft. from the building line at the sidewalk level across the street or roadway, or that a roof of the mansard type, containing such stories may be constructed with similar angles of light.

3. It shall not be permissible to construct any cornice with a greater projection than 3 ft., but in no case shall the projection of a cornice obstruct a 60-deg. angle of light given from the intersection of building and sidewalk lines at the opposite side of the street or roadway.

TOWERS

4. No limit in height shall be placed upon a structure to be called a tower having an area not exceeding 25 per cent of site, providing that no portion of the tower shall be allowed within a distance of the building line at least equal to the distance of first curb from such building line, except where such building faces upon a public park, public square or body of water, then such area of 25 per cent may be built as a tower on the building line at sidewalk level, but proportions of tower shall be such as not to exceed in width more than one and one-half times its depth in any case.

5. Where any building is erected or intended to be erected on a corner lot so as to abut upon more than one street the height of the building shall be regulated by the width of the widest of such streets, and also so far as it abuts upon the narrowest of such streets, the height given by the widest street may be carried to a distance not exceeding 66 ft. from the widest street. All such heights shall be measured on a perpendicular line taken directly up at the building line from the intersection of such building line and sidewalk at the street level, at the center of lot or frontage, to the top of the parapet wall, and shall include in height all cornices. Pent houses for elevators and inclosures for tanks may be erected above such maximum height, but they must be so located on roof that they will not lessen the 60-deg. angle of light hereinbefore prescribed, and the total area of pent houses and tank inclosures shall not exceed 12½ per cent of the total area of the roof.

Effect of Creosote on Timber in Galveston Bay

Comparative Condition of Piles Lightly Treated in 1875, Others Well Treated in 1895 and Still Others Used Untreated in 1909

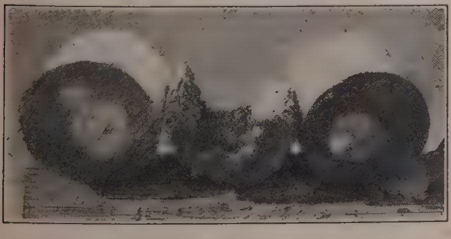
COMPARATIVE results of the serviceability of untreated, inadequately treated and thoroughly treated piles in Southern waters were afforded in dismantling the bridge of the Atchison, Topeka & Santa Fé Railway across Galveston Bay following the opening of the Galveston causeway in 1912. For the first bridge, built in 1875, creosoted piles were used, but the amount and character of the creosote, as well as the amount of previous seasoning, are unknown. In 1895 the trestle was reconstructed, the new piles being treated according to the best practice of that period. Many of the piles of the original trestle were left standing between the bents of the new structure. When the causeway was started, in 1909, untreated piles were driven to strengthen the trestle. In the dismantling of the old structure, which took until last summer, all three classes of piles were removed and examined for the International Creosoting & Construction Company, of Galveston, by F. B. Ridgway, in charge of the department of chemistry and tests. Mr. Ridgway's report, from which these notes are taken, is printed in full in the "Proceedings," just issued, of the tenth annual meeting of the American Wood Preservers' Association. It shows that the thoroughly treated piles were almost all in good condition, that while the majority of those lightly treated in 1875 were almost completely eaten away from mud line to water line, a few were in good condition, and that the untreated piles were practically destroyed.

OLDEST PILES

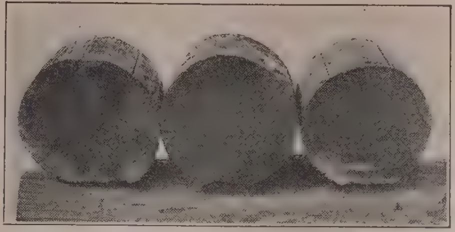
There is no record of the method of treatment or of previous seasoning of the piles in the original trestle. It is known that the treatment was light—probably between 8 and 12 lb. per cubic foot. When these piles were removed, after twenty years' service and eighteen more years in the water, the air sections were found to have lost almost entirely all outward signs of having been treated. The hearts were in many cases badly decayed, while the outsides were sound. In other cases, even where no more than half of the stick had been penetrated, both heart and outsides were in good condition. The variation is attributed to the amount of butt cut off after driving and the consequent varying amount of untreated wood exposed.

In the majority of cases the water sections were more or less attacked by the teredo and limnoria. A few of these sections were practically sound, but many were almost completely eaten away.

Air, water and mud sections of a typical pile driven in 1875 are shown. The pile, which is about 11 in. in diameter, shows a 3½-in. penetration and a 4-in. untreated center, with a very sharp line of demarcation.



Sections of Typical Pile of 1875 Lot



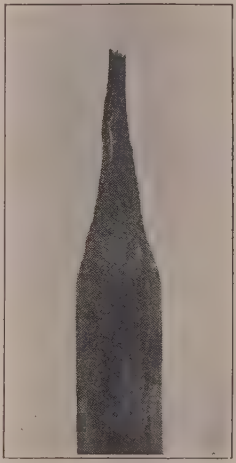
Unattacked Pile Well Treated in 1895

Note—In each view the three sections from left to right are air, water and mud sections.

PILES TREATED IN 1895

Pine piles direct from the stump, seasoned by steaming, were used in the majority of cases when the trestle was rebuilt in 1895. The piles were treated by Ricker-Lee & Company, of Galveston, now the International Creosoting & Construction Company, and were guaranteed for ten years, the company agreeing to replace free of charge any pile found defective at the end of that time. None had to be replaced.

For one reason or another it was impossible to get an actual count of all the good and defective 1895 piles taken out when the trestle was dismantled. It is estimated by George E. Rex, manager of treating plants of the Santa Fé system, that less than 10 per cent were unfit for use elsewhere. On actual count of sixty-five, fifty-eight were in perfect condition, six were slightly attacked and one was worthless.



Untreated Pile Eaten in Two by Limnoria

Included in the piles treated in 1895 were 110 of red cedar. Fifty of these were broken in pulling, but fifty-three have been located elsewhere and are found to have been attacked only slightly, in spite of the difficulty of injecting any large amount of oil into red cedar.

The oil used in the piles treated in 1895 was what was then known as "heavy oil," not on account of high specific gravity but because at ordinary temperatures it contained a large per cent of solid matter. It was imported English oil, which, as extracted from the mud sections, was found to be a low boiling oil containing 60 per cent of naphthalene and somewhat more than 12 per cent of tar acids.

UNTREATED PILES

A view is shown of one of the untreated piles. Though placed comparatively recently, it has been eaten completely in two by limnoria, the limnoria working from water line to mud line. There is also evidence of teredo action.

In regard to the creosoted piles it is noted that in many instances where the pile has been attacked the borers have entered through knots, and that most of the 1895 piles that have suffered are very resinous. Operators are well aware that it is very difficult to force oil into knots or resinous pieces of timber. From the analyses made Mr. Ridgway thinks the pieces that were attacked received less than the average amount of oil on account of their refractory character. Untreated piles examined indicated that the knots were less attacked than the softer wood around them; hence the resistance of knotty and resinous piles to oil penetration is blamed, rather than the structure of the wood itself, for the vulnerability of this class of timber.

Another Masonry - Placing Record at Kensico Dam

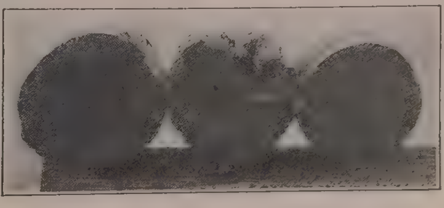
During Twenty-four Working Days in May Progress Is 66,290 Cubic Yards

LAST year's record yardage of masonry placed in the Kensico dam of the Catskill Aqueduct at Valhalla, N. Y.—53,240 cu. yd. in a single month of twenty-five working days—was exceeded during the month ended May 24, when the enormous volume of 65,290 cu. yd. was placed in twenty-four working days. Except for block setting, which is done at night, the work is carried on in only one shift of eight hours per day.

The placing of masonry was resumed in Kensico dam on March 17, and in a little more than two months a total of 120,900 cu. yd., or more than one-third of the total placed in the whole of last season, has been added. The 65,290 cu. yd. placed in May are 23 per cent in excess of last season's best effort. The best day's work so far this year is 3165 cu. yd., against 2280 cu. yd. last year. The daily average for last year's best month, 2130 cu. yd., is this year increased 28 per cent to 2720 cu. yd.

Three mixers are in use, each of nominal 2-yd. capacity. The best day's work for one mixer is 507 batches, a rate of one batch every 57 seconds. The contractor's plant and methods of operation were described by George T. Seabury in the Engineering Record of Jan. 10, page 34. The work is being done for the Board of Water Supply of New York City by H. S. Kerbaugh, Inc., of Philadelphia.

THE BASEBALL stadium at Washington Park, Brooklyn, is partially inclosed by a brick wall 12 in. thick, 20 ft. high and 1080 ft. long on a concrete footing 6 ft. wide and 18 in. thick. The wall was originally designed for a height of 12 ft., and when it was increased to 20 ft. it was decided to reinforce it. Recesses 6 in. wide and 16 ft. apart were cut in the face of the wall from top to bottom to receive vertical 10-in. channels 16 ft. high. The feet of these channels were provided with angle-iron kneebraces anchored to the footings, and the upper ends were connected by 1-in. horizontal screw rods embedded in the brickwork.



Attacked Pile Well Treated in 1895

New Type of Driver for Large Concrete Piles

Equipment Specially Designed for Use in Building the Reinforced-Concrete Pier of the Intercolonial Railway at Halifax

A FLOATING pile driver of an unusual type, and more powerful than any previously built, has been used in building the new pier of the Intercolonial Railway at Halifax, N. S. Not only will the machine handle heavily reinforced-concrete piles 24 in. square and as long as 77 ft., but it will drive them in threes, one after another, without change of position, and will handle batter piles with equal facility.

The pier and shed are entirely of reinforced concrete. The pier is 800 ft. long and 235 ft. wide and is supported on 1800 of the 24-in. concrete piles, which range in length from 57 to 77 ft., and are each reinforced with eight steel rods from 1 to 1¼ in. in diameter, according to the length of the pile. To get the piles down to rock they have to be driven through from 3 to 14 ft. of hardpan. The design calls for some of the piles to be driven in groups of two or three, side by side, with practically no space between them, and for diagonal piles battered 15 or 16 deg., driven close against the faces of the vertical piles in order to brace them.

A wood hull 108 ft. long, 45 ft. wide and 12 ft. deep at the bow carries the pile driver. In order to support the leader carriage tracks, there are solid timber bulkheads from bow to stern, and also several transverse trusses.

CARRIAGE

The drums and machinery for handling the piles and operating the hammer are supported on a heavy structural-steel carriage, mounted on rollers which travel on a track, and the whole is moved by means of a rack-and-pinion drive. The front of the carriage is provided with two heavy girders. The upper girder carries a trunnion bearing, which supports the weight of the leaders, while on the lower girder is a specially designed crosshead attached to the leaders in such a way that they are held firmly. Trunnion bearing and crosshead are connected to independent screw shafts driven by an engine; hence simultaneous operation of both shafts will move the leaders laterally across the carriage, while operation of either shaft alone will swivel them. In this way a transverse motion of 8 ft. as well as a fore-and-aft play of 7 ft. is provided, and canting of the leads to take care of the batter piles is also made possible.

Two forward spuds, each provided with an independent engine, hold the driver in position when in action. The spud machinery, which is located well aft, is connected to the spuds by wire ropes and is controlled by levers within reach of the engineer from his position in the traveling leader carriage. There is a third spud at the stern.

At first it was thought that piles as long as 90 ft. would be required, and the length of the leaders was fixed to accommodate such piles. The leaders are, therefore, 76 ft. long over all, standing 70 ft. above the deck.

HAMMER

The steam hammer is said to be the largest double-acting steam pile-driving hammer ever made. The combined weight of hammer, follower and follower guide is approximately 28,000 lb. The cylinder is 14 in. in diameter and of 36-in. stroke, and the weight of the ram alone is 4000 lb. With a mean effective steam pressure in the cylinder of 80 lb. per square inch the hammer is rated to develop 3,916,000 ft.-lb. per minute when the hammer is striking eighty blows per minute.

In order to take care of the reinforcing bars, which project 3 ft. above the ends of the piles, the hammer is fitted with a special cap. The leaders are equipped with a special hammer track, by means of which the hammer when hoisted can be switched in out of the way of a swinging pile. An automatic locking device is provided at the top of the leaders to support the weight of the hammer while the pile is being placed in position, and there is also an intermediate stop to hold the hammer when the driver is not in use.

Scows deliver the piles to the driver, two derricks handling them. The machine was originally intended to drive one pile an hour, but has proved able to handle twenty or twenty-five in a ten-hour working day.

The pier is being built by the Nova Scotia Construction Company, Ltd., of Sydney, N. S., under the direction of John Kennedy, consulting engineer, of Montreal, and A. F. Dyer, his local representative. The Bucyrus Company, of South Milwaukee, Wis., designed and built the pile-driving machinery, collaborating with W. L. Scott, chief engineer of Mussens, Ltd., of Montreal, who was consulted by the contractors and who designed the hull and the derricks. The Union Iron Works, of Hoboken, N. J., designed and built the steam hammer.

Ready to Drive a Brace Pile

Near View of Driver Working on One of the Vertical Piles

Preliminary Report on Waterworks at Dayton, Ohio

UNACCOUNTED for water pumped in Dayton, Ohio, amounts to 2,630,000 gal. per day, a loss of 21 per cent, even after allowing 20 per cent for underregistration of meters, 5 per cent due to slip in the pumps and a 3000-gal. leakage per mile of mains. These figures were presented to J. E. Barlow, director of Public Service, by S. G. Pollard, consulting engineer, at a conference with Henry M. Waite, city manager, on April 24. It was decided to institute a pitometer survey immediately to locate the large leaks.

The average daily consumption for 1914 is estimated at 11,000,000 gal. daily, the maximum rate being 24,250,000 gal. daily, with a possible fire-service demand of 32,250,000 gal. daily for short periods. In 1950 it is estimated that 205,600 people will use 32,750,000 gal. per day.

For temporary relief in the high-service district, Dayton View, Mr. Pollard recommended moving the Linden Avenue pumps to the main pumping station, making various new pipe connections to serve high-service districts. This plan is to be in operation by May 15, but further permanent relief can be obtained only by constructing a 20-in. main from the pump house to the center of the territory. Studies to afford permanent relief are now under way.

MAINTENANCE OF WATER meters in Chicago cost $6.03, $5.26, $4.73, $4.45 and $3.97 apiece for the past four years, respectively, according to the 1913 annual report of John Ericson, city engineer. There was a total of 16,969 meters in service on Jan. 1, a net gain of 959 during the year. Designs and tests have been made of sample meters built in the city's shop ranging in size from ¾ to 2 in.

Rules for Evaluating a Railroad Property

Compiled from Directions Issued by William J. Wilgus for the Guidance of His Staff in the Appraisal of the Lehigh Valley

A CRITICISM of the much-discussed report of the American Society of Civil Engineers' valuation committee was that it confined itself to the general governing principles of valuation and ignored the detail problems of gathering and assembling the data. These principles, as well as an analysis of the value of the Lehigh Valley Railroad, were discussed in the Engineering Record of May 16, page 552, in the abstract of the report of William J. Wilgus, consulting engineer, who recently appraised the property. There was also in the report an appendix on rulings, forms, diagrams and tables of quantities—primarily intended for the guidance of his staff. With the tenses changed to some extent, this appendix may be regarded as a general specification for the evaluation of any large railroad. While space will not permit publication of the full text, nor reproduction of more than a few specimen forms, the main points are believed to be covered herein.

All property owned or used by the railroad company for its purposes as a common carrier should be included in the valuation. Property held for purposes other than those of a common carrier should be shown separately.

Quantities should be estimated for the date determined in advance of the valuation. Suitable corrections or adjustments should be made for any changes that may occur between that date and the time of observation or recording of data.

The road should be divided into valuation districts, and these in turn into main line and branches, or into various corporations, as may be decided in each case. Each main line, branch or corporation should be subdivided and numbered so that the data may be later available for estimating the cost of transporting commodities from various originating points to their destinations, and also in verifying values and in tax matters. Moreover, the ascertainment of costs per mile by subdivisions will make possible a close general check on the accuracy of the results.

Forms and tables should be prepared for facilitating and checking office and field work, and for recording results in such manner that the authority in each instance may be easily traced back to the parent source.

All physical property, as nearly as practicable, should be classified in conformity with the classification of expenditures for road and equipment, as prescribed by the Interstate Commerce Commission.

CONSTRUCTION DISTRICTS

In reproducing or duplicating a large railroad system it would not be possible to divide the work into small units, as is usual for minor extensions of an established railroad. The road would be divided into construction districts of sufficient size to attract responsible contractors, who in turn would divide their respective territories among small sub-contractors. Therefore, except in localities where a large amount of work is embraced within comparatively short limits, each district engineer in determining unit prices that are affected by local conditions should divide his territory into sections of considerable length, say 50 miles or more, depending upon geological formations, topography, magnitude of work, availability of materials, accessibility, overhaul, and other conditions that would naturally cause variations in prices and affect contractors in bidding upon the work. This procedure excludes consideration of each particular cut or fill or other detail, and calls for a study of the territory as a whole, in the same manner that would occur in the actual construction of the line.

To insure uniformity and consistency, the district engineers should use the adopted tentative prices, except where local conditions affect the cost of doing the work, or where the records of the railroad in question show that modifications are required. Departures from the tentative prices will in each case be noted and explained on the proper form.

The tentative prices may be said to consist of two general classes—(a) those that rise and fall with the financial and industrial conditions of the country and, therefore, are based on averages over a period of years, such as cement, brick, and iron and steel products, and (b) those that show a constant increase and, therefore, are based on current quotations, such as ties, piling, lumber and labor.

Whenever the district engineers need special assistance, as on important buildings or mechanical features, the desired information should be furnished from the company's records or by other engineers engaged for the purpose.

RECORD OF DETAILS

Quantities and prices should be recorded on a form similar to the specimen half-page shown. There should be enough of these pages to cover all of the forty-eight Interstate Commerce Commission primary accounts and all items entering into the physical valuation of the permanent way. These pages should be bound as right-hand pages, and facing them should be blank pages for remarks.

Sufficient data should be shown on the "remark" pages to indicate clearly the bases for calculation of quantities and modifications of tentative prices.

In the condition column the amount of depreciation and appreciation should be indicated in dollars, with the prefixes — and + respectively; and opposite each entry the reasons therefor should be given on the remark page.

Spans, character and quantities of substructures and superstructures of each bridge and important culvert should be noted, preferably in tabular form.

Weights of rail in main line and in sidings and yards should be indicated.

The name and a brief description or sketch, with governing dimensions, should be given of each important structure, including large bridges and viaducts, tunnels, passenger and freight stations, shops, fuel and water stations, etc.

Depth and nature of both visible and concealed ballast should be shown.

Important facilities used for system purposes, like the general repair shops, should be grouped on separate forms of a similar type so that their values may be segregated from facilities devoted to local or divisional purposes.

The number, character, dimensions and contents of several buildings or other structures of the same class may be tabulated opposite the place of entry.

Reference should be made on the form to all underlying sources of information, so that they may be readily located.

Facilities owned by the company and temporarily leased to others should be included in the valuation if they are owned for the purposes of a common carrier, even though not so used at the time of the valuation. Such temporary leases may be considered as having been made indirectly for the benefit of the public or to assist in carrying unremunerative property held pending the time when its use may become necessary for the expanding needs of the company. Leased property, including lands and structures, not owned for the purposes of a common carrier should be shown separately.

Ownership of sidings exterior to the right-of-way, when not ascertainable from the company's records or from the reliable testimony of company employees or others, should be determined by the manner in which the sidings are maintained.

DEPRECIATION AND APPRECIATION

Depreciation, modified by appreciation of those parts that improve with time, should be based on actual conditions and on suitability for continued use. As a rule, three types of structures will be found: (a) Those good for an indefinite continuing life, provided they are fundamentally sound, such as bridges and buildings; (b) those good for an indefinite continuing life, during the early stages of which there is a gradual diminishment of value, followed for many years by fixed value, such as rails and some kinds of timber structures; and (c) those having a fairly definite life fixed by past experience, such as ties and some types of machinery.

These remarks apply to that feature of depreciation that is usually termed decrepitude. Obsolescence of "road" items, being purely speculative, is in this case not believed to be proper for consideration, except for items like machinery. In the case of equipment and machinery, obsolescence as well as decrepitude should be considered, as past experience has proved that there is a well-defined period of economic life beyond which continued use is wasteful or unproductive.

LANDS

Lands should be divided into three classifications: (a) Right-of-way and station grounds used for roadbed, station grounds and terminals; (b) real estate held for the purposes of the road as a common carrier, other than that actually acquired for roadbed, or station or terminal grounds; and (c) lands held for purposes other than those of a common carrier. The latter should not be included in the common-carrier valuation, but should appear as a separate item.

Each of the three classifications should be valued on three different bases—original cost to date, basic cost as measured by the value of neighboring lands, and reproductive cost, in which provision should be included for the usual excess costs that are known to accompany the purchase or condemnation of railroad lands due to severance and other damages. All three bases of value should embrace the costs of acquisition, such as maps, surveys, legal and condemnation expenses, recording fees, salaries and expenses of right-of-way agents, and damages, as provided for in Interstate Commerce Commission classifications 2 and 3.

In obtaining the existing normal or basic values of real estate along the line of the railroad, as a basis upon which to predicate the cost of reproducing the right-of-way and real estate of the company, a careful record should be made of the names and addresses of the authoritative sources of such information, so that if needed they may be easily located for the purposes of verification.

Wherever waterfront lands, in a reproduction of the system, would naturally be reclaimed or improved by the railroad, the valuation thereof should be taken unimproved and the costs of reclamation and other improvements estimated separately by the district engineer and rendered under their appropriate Interstate Commerce Commission headings. Any appreciation of values that may have resulted by reason of the construction of the railroad facilities, in excess of the cost of improvements, will not be includable in the "cost of reproduction new." In cases, however, where it is evident that the acquisition of the waterfront lands would include therewith reclamation, such as dredging, bulkheading and filling, as, for instance, at places where such improvements antedated the building of the road, the land appraisal should take this into consideration and the engineer's estimate of the cost of the improvements should not include the items so embraced in the land values.

Where there is no record of ownership of right-of-way the width of easement or ownership, other than at crossings of thoroughfares, should be assumed to be 21 ft. for single track, 33 ft. for double track and proportionately wider for a larger number of tracks. The slopes of cuts and fills should be considered as running on to adjoining property holders.

Where the tracks of the company cross thoroughfares or other spaces used in common with others, including streets, highways and navigable streams, either at grade or over or under, one-half the value of the space so occupied should be included in the appraisal.

Buildings or other improvements belonging to the railroad company and located on lands not used directly for railroad purposes, if constructed since the date of the acquisition of the land on which they are located should be included under account 31, "miscellaneous structures," or under "property held for purposes other than those of a common carrier," the former classification to be employed if the structure is on land held for the purposes of a common carrier, even if temporarily leased or used for other purposes. If, however, such building or other improvements were on these lands when acquired their value should be included in the estimates of the right-of-way and real-estate representative. The district engineers and right-of-way and real-estate representative should confer so as to avoid any duplication or omission of such values.

The value of the company's equity in leaseholds, such as dock leases, should be taken at the present cash value of the amount that it is estimated will have been saved through non-ownership at the expiration of the lease. This amount is obtained by taking the difference between the aggregate annual payments that would be payable for the remaining term of the lease, if based on a fair interest return on the present value of the property, and the aggregate of the actual rentals named in the lease for the same period, due regard being had for taxes and assessments.

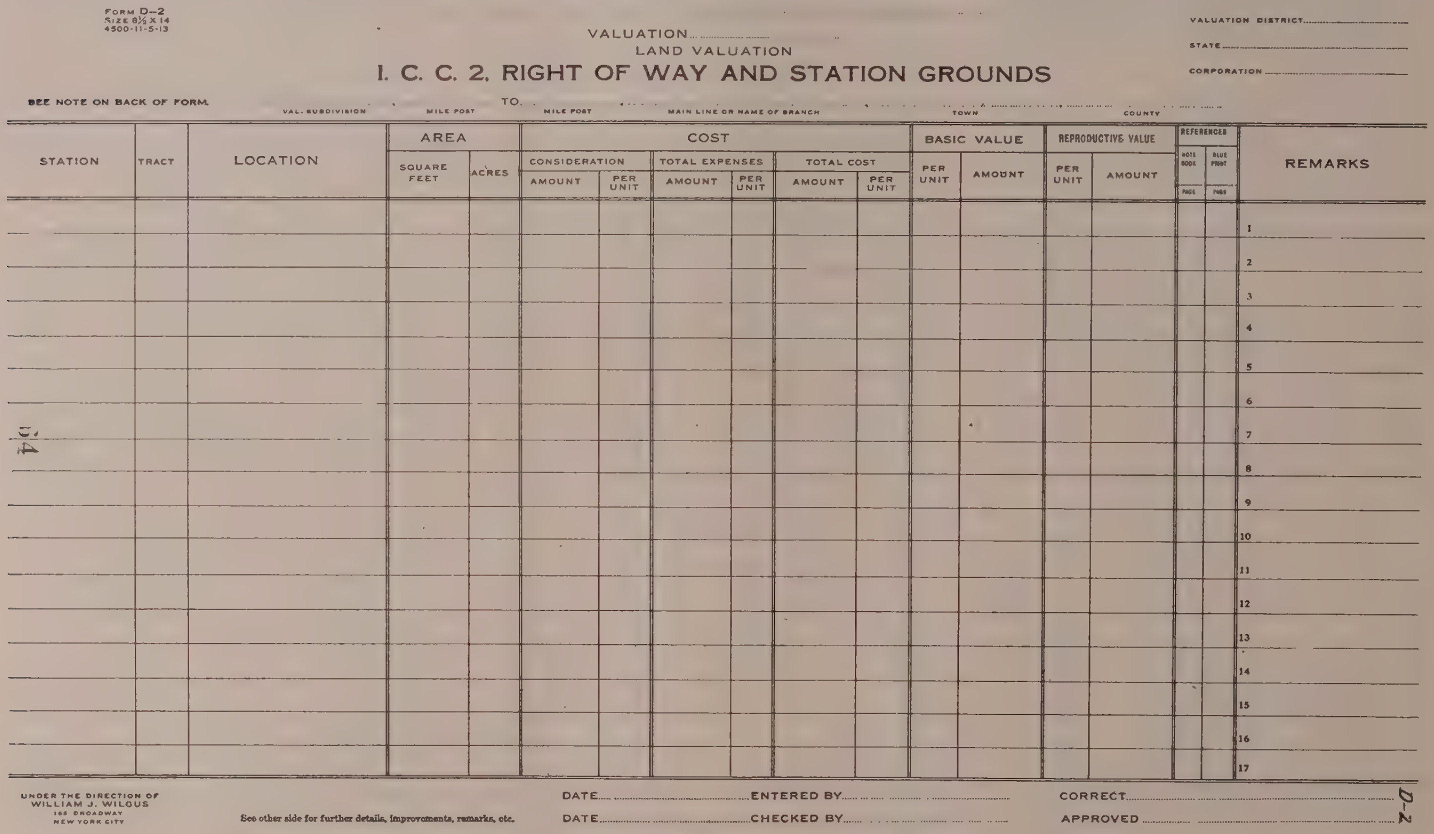
Experience has shown that separation of earth excavation into various classes is provocative of litigation due to the impossibility of clearly defining the line between them. Therefore the adopted prices for earth should be understood to include ordinary earth, hardpan, earth borrow and all other materials not includable under loose and hard rock. In some instances the difficulty of determining loose rock may make it advisable to have the price for earth also include that item, in which case a note to that effect should be made on the form.

Determination of prices for rock excavation should depend upon hardness, ease of disposition, feasibility of employing labor-saving devices and the need for care in blasting due to the proximity of habitations, industries and railroads, canals and other thoroughfares.

In deciding upon unit prices and also the required amounts of borrow, the question of overhaul, for which no separate price is given, should be taken into consideration. The length of haul within which waste will not be permissible will vary with local conditions. For small cuts and fills operatable with scrapers and wagons 1000-ft. haul is proper; for large cuts and fills warranting the use of steam shovels and narrow-gage equipment, hauls of a mile or more are proper; for heavy work warranting the installation of broad-gage equipment, haul of several miles may be considered.

Surrounding conditions should be studied to determine whether road and channel changes were necessary in the construction of the road, so that the quantities therefor may be estimated. In some instances it may be necessary to examine the records of the company or to make local inquiries.

As is well known, some materials taken from excavation swell when placed in embankment so as to increase the yardage utilizable for filling, and others shrink so as to increase the yardage required for filling over and above the amount taken from excavation. Rock excavation swells, the amount varying from, say, 15 per cent for



Form D–2
Size 8½ x 14
4500-11-5-13

VALUATION........
LAND VALUATION

I. C. C. 2. RIGHT OF WAY AND STATION GROUNDS

VALUATION DISTRICT........
STATE........
CORPORATION........

SEE NOTE ON BACK OF FORM.

.... VAL. SUBDIVISION .... MILE POST TO .... MILE POST .... MAIN LINE OR NAME OF BRANCH .... TOWN .... COUNTY

STATION	TRACT	LOCATION	AREA		COST						BASIC VALUE		REPRODUCTIVE VALUE		REFERENCES		REMARKS
			SQUARE FEET	ACRES	CONSIDERATION		TOTAL EXPENSES		TOTAL COST		PER UNIT	AMOUNT	PER UNIT	AMOUNT	NOTE BOOK	BLUE PRINT	
					AMOUNT	PER UNIT	AMOUNT	PER UNIT	AMOUNT	PER UNIT					PAGE	PAGE	
																	1
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UNDER THE DIRECTION OF
WILLIAM J. WILGUS
165 BROADWAY
NEW YORK CITY

See other side for further details, improvements, remarks, etc.

DATE........ENTERED BY........ CORRECT........ D–2
DATE........CHECKED BY........ APPROVED........

One of Eight Forms Used for Right-of-Way and Real Estate on Lehigh Valley Evaluation

I. C. C. PRIMARY ACCOUNT	QUANTITY	UNIT	SUBJECT	PRICE		AMOUNT	CONDITION	NOTE BOOK	
				TENTATIVE	MODIFIED			NO.	PAGE
1. Engineering		5% on	all items except Nos. 2 and 3.						
2. R. of Way and Sta. Grounds			See Form E	Special					
3. Real Estate			See Form E	Special					
4. Grading		Acres	Clearing	$40.00					
		100 S. F.	Grubbing	.64					
		C. Y.	*Excav.						
		"	" Earth	.25					
		"	" Loose Rock	.60					
		"	" Solid Rock Soft Med. Hard	1.00 1.20 1.40					
		"	" Under Water	2.00					
		"	" Old Masonry	2.00					
		"	"						
		"	"						
		"	"						
		"	"						
		"	"						
		L. F.	Piling W. O.	.40					
		"	" Y. P. Inland Tidewater	.35 .30					
		"	"						

Portion of Detail Form Covering the Forty-eight I. C. C. Accounts

the kind of rock that breaks into various sizes and is subject more or less to disintegration, to 50 per cent or more for clean hard rock breaking into large masses. The amount of swell should be estimated by the district engineers after consulting local conditions. Earth excavation shrinks, the amount varying from 5 per cent for certain materials like gravel or sand to 15 per cent for loam, light sandy earths and soil.

CONCEALED CONDITIONS

Where the roadbed passes over swamps, bogs, "meadows" and abandoned mines or other points where there has been settlement due to underlying conditions, an attempt should be made to ascertain the volume so filled; but if no reliable data are obtainable upon which reasonably to determine such quantities, nothing should be included therefor in the estimate. It should be borne in mind that the quantities required for settlement are in addition to those needed for shrinkage.

The nature and depth of foundations for bridges and other structures where possible should be ascertained from the company's records, testimony of employees and other reliable sources. When necessary other means may be taken, as by digging, and by assumptions as to what would be necessary to be done in reproducing the structures under the known conditions of underlying soil and ground water level.

In bad material, such as clay, the entire surrounding country frequently settles and forces up the bottoms of the cuts, necessitating excavation that does not appear within the calculable prism. While this element must usually be ignored, it should be borne in mind and an allowance made therefor if it can reasonably be done. The same remark applies to the sliding of the toes of embankments, which frequently become grassed over in time and are not readily observable.

Prices for tracklaying having been determined on the basis of expeditious uninterrupted progress, the erection of temporary single-track trestles in advance of the tracklaying would be necessary on all lines other than minor spurs and unimportant branches. Therefore provision should be made for this item for openings of more than 30 ft. Spans for lesser openings may be assumed to be taken to the "front" and placed in connection with the tracklaying.

APPRECIATION OF CUTS AND FILLS

Embankments in the course of time undergo solidification following impact of rolling stock and the action of the elements. This seasoning has a value that may be gaged by the amount that it would cost the company to obtain practically the same desirable condition at the time of the construction of the road. This cost will range from 5 to 10 cents per cubic yard, depending on availability of water, nature of material, volume and degree to which this requirement will interfere with the ordinary manner in which the embankments would be built. As a rule, it will be conservative to take 5 cents per cubic yard where the conditions are favorable, as, for instance, with plenty of available water, and noninterference with ordinary methods of depositing, and 10 cents per cubic yard where conditions are not so favorable. The age of the banks should also be taken into account, the figures above quoted being the maximum for embankments that have become well seasoned over a period of years. Suitable reductions in cost should be made for the less aged embankments.

Excavations on a new railroad are known to give much trouble from slides and filling up of ditches, entailing constant labor, often with the use of work trains, until the surface of the cuts adapt themselves to conditions, or, in other words, become seasoned. While in the case of embankments it is possible to measure appreciation by the equivalent cost of artificially compacting them, it is not so easy definitely to fix the value of appreciation in excavations; but a close approximation can be made. On a new railroad it may be said that for average material, in, say, a depth of 20 ft., a work train with twenty cars and twenty men, costing $80 daily, will be required about twelve days in the first year for each mile of road in cut, or, say, $1,000 per mile of 20-ft. cut. This sum may be used as a guide in determining what amount per mile should be added for appreciation on excavations, taking into account, of course, their depth and age and the nature of the material.

Where slopes for fills and cuts in the course of time have become grassed or otherwise covered with vegetation that protects the surface, allowance for appreciation should be made in the condition column opposite "sodding."

Masonry in first-class condition and, as

BALLAST

Track	Kind of Ballast	Depth	Ties per 100 Feet	Dist. C. to C. of Track	From M. P. Plus	To M. P. Plus	Distance Feet	Deduct for Bridges Turnouts etc.	Net Track Ballasted Feet	Ballast per 100' Track cu. yds	Total Quantity of Ballast cu. yds.	REMARKS

Special Form for Recording All Details Pertaining to Ballast far as can be judged, good for an indefinite period should have its depreciation measured by such expenditures as, for instance, pointing, if needed, or sundry repairs, as may be necessary to put it in 100-per cent condition. If the masonry is in shaky condition and in obvious need of entire renewal, this should be taken into account, and in such instances the depreciation may be equal to almost the entire value of the structure.

Where steel or iron bridges are in good condition and well suited to the purpose for which they are being used, their depreciation should be measured by the cost of whatever little attention or repairs may be necessary to put them in 100-per cent condition. For instance, if painting is required, depreciation may be measured by the cost of repainting, which, including cleaning, may be roughly estimated at $1 per ton. On the other hand, if the structure has been allowed to deteriorate so that rust has largely destroyed its usefulness, the cost of replacements should be used in fixing the amount of depreciation.

Timber Trestles

Timber trestles and coal pockets if maintained in first-class working order may be considered as having a minimum value of 50 per cent, the loss of 50 per cent being spreadable over the ordinary life of the kind of timber of which the structure is composed. For instance, a yellow-pine trestle, having a timber life of the constituent parts of, say, ten years, would be depreciated 5 per cent per annum to a maximum of 50 per cent, beyond which the value would be considered stationary as long as the structure was well maintained and suitable for indefinite continued use. Trestles in a racked or dilapidated condition and obviously not susceptible of indefinite maintenance may be depreciated as much as 75 per cent, 25 per cent of full value being considered the minimum value of a structure still in active use.

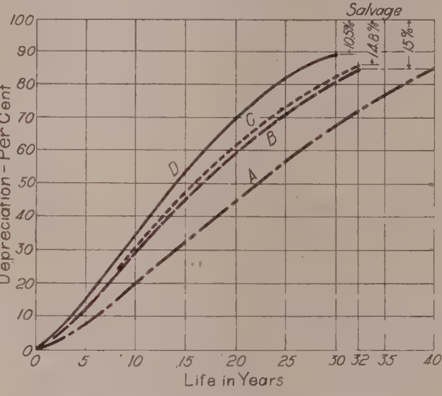
At tunnels inquiry should be made as to the nature of the material and the methods followed during original construction, to determine the neat line to which to figure for excavation, and also whether or not to include timbering. In self-supporting hard rock the neat line would presumably be 6 in. beyond the extrados of the masonry lining, with no timbering; in bad rock requiring support during construction, the neat line would be out far enough to permit the placing of a temporary timber lining within which to construct the masonry. Not only should timbering be borne in mind, but also packing between the extrados of the masonry lining and the irregular intrados of tunnel excavation. The hardness of the rock and encountering of water during construction will have a decided influence on the question of cost.

Ties and Rails

Each engineer should satisfy himself as to the number, dimensions and material of each class of tie in use. From the storekeeper may be obtained the number supplied in a given territory for a considerable period so as to work out a percentage per mile, checking the information by counting the various kinds of ties per rail length in different locations, or by inquiry through the maintenance department, or otherwise.

Assuming that average annual tie renewals take place as of July 1, and assuming an average untreated tie life of eight years, the percentage of depreciation of all untreated ties as of December 31 would be 50 per cent. It does not seem proper to decrease this ration on the higher-grade lines, where it may be claimed that ties are taken out before their timber life is yet unexpired. For the purpose for which ties are in use on the higher grade lines their life has ended when they are removed. They are then practically worthless for any other purpose, even though their life as timber has not expired.

Rail usually passes through several stages before it is unfit for further use in track. First it is utilized on the more important lines until its condition becomes such as to make it unfit for high-speed passenger trains. Then it is transferred to lines of minor traffic, or to sidings and yards, where it may remain for an indefinite period. It is manifestly improper to attempt to measure depreciation on an arbitrary mortality basis, as in some instances the character of traffic may be such as to wear out the rail in one-half or one-third of the assumed ultimate life, and in other cases the traffic may be so light as to permit the retention of the rail in service for possibly twice the assumed ultimate life. Therefore the depreciation of the rail in each instance must be judged by its actual condition and the kind of traffic that it bears.



Depreciation of Marine Equipment

A—Steel steam vessels on Great Lakes
B—Steel steam vessels on tidewater
C—Steel barges, floats, etc., on tidewater
D—Wood tugs, barges, etc., on tidewater

Commercially considered, there are three classes of rail—new, relayer and scrap. Between the first two there is beyond question a gradually decreasing range of value from, say, $30 for the new, to $20 for the relayer, a difference of $10, which may be said to be spreadable over a period of ten years—the average time that rail may be said to be fit for the higher classes of service. On this basis the annual depreciation may be taken at $1 per ton, with a maximum total depreciation of $10, subject to such modifications as the engineer may deem proper by reason of local conditions or quality of rail.

Judgment should be used in determining the depreciation of track fastenings, including splices, bolts, spikes, tieplates, etc. In the absence of special reason for doing otherwise the depreciation may be taken at the same rate as the rail with which they are associated, plus 10 per cent. Depreciation on frogs and switches should be determined by local examination, as they wear out much faster than the rail and fastenings with which they are associated.

As a rule, on main lines the vertical depth of ballast should be measured from subgrade at the shoulder just outside of the edge of ballast to the top of tie, but in some instances, especially in yards, it may be difficult correctly to determine the depth. It has been found in many places that cinders or other ballast exist to a depth of 2 ft. or more below the bottom of tie. The depth in each instance should be obtained by digging or careful inquiry, and the amount as it actually exists calculated, not, however, to exceed the maximum depth of 12 in. below the bottom of tie, unless a greater depth is visible above the top of roadbed. If the concealed ballast material extends to a greater depth than 12 in. below the bottom of tie, the yardage for an additional depth, not to exceed 12 in., should be considered in determining appreciation of ballast.

Although provision is made in the track-laying price for the labor of preliminary surfacing in order that the rail may be protected during the construction period, no allowance has been made for the extra material required from the shoulders of the banks, which later must be replaced by construction trains. It may be assumed that 400 cu. yd. per mile are required for this purpose, at an average price of 25 cents per cubic yard, or $100 per mile of single track. This provision may be omitted for the less important industrial and mine branches, where preliminary surfacing for the preservation of rail would not be necessary.

Seasoning of Ballast

For a considerable period after tracks are first ballasted there is more or less trouble and expense involved in preserving line and surface, particularly during periods of wet and frost. This is due to the working of the ballast into the roadbed, to the filling of interstices from beneath and to the fact that the ties have not become solidly embedded in the ballast. As a consequence of these conditions extra labor is required constantly to readjust the track, and there is an absence of smooth riding of trains that is so essential to fast passenger traffic and to the minimizing of repairs to track and equipment.

As time goes on the track is raised on new ballast so as to maintain it at its original height; and the original ballast is pressed or settled downward into the roadbed where it remains as a firm semi-porous substratum to protect and sustain the overlying newer ballast. This newer ballast is the visible portion that appears above the top of the shoulders and is to be measured and estimated as "ballast." The older or concealed ballast is incorporated in the roadbed, and while it is not measured and estimated as ballast, its value is reflected in the appreciated worth of the part that is measured and estimated.

Structures carrying the tracks of the railroad in question over those of other railroads should be included in this valuation, even though they may be maintained by the other company. This is on the theory that structures on the right-of-way of the company for maintaining the continuity of its tracks and acting as substitutes for original embankments are the property of the company and includable in its valuation. Conversely, structures carrying the tracks of other companies over the railroad in question should be excluded, even though in some instances maintained by the latter company.

At railroad grade crossings the cost of interlocking plants should be divided in the proportions on the statement prepared by the signal engineer. Crossing frogs should be included in the valuation where the obligation of maintaining and renewing them rests with the railroad that is being valued.

At highway and street crossings constructed at the time that the railroad was originally built, the entire expense of the structures and appurtenances, including abutments, superstructure and approaches, should be included in the valuation. If it is obvious that later work, such as paving, was done by the town or municipality at the expense of the public long after the crossing was built, the cost thereof should not be included.

TABLE 1—ANNUAL DEPRECIATION OF LOCOMOTIVES IN PERCENTAGES

	Boiler pressures		
Type	200 lb. and more	150 to 200 lb.	Under 150 lb.
Passenger	4¼	3¾	3
Freight	5	4	3
Switching	3½	3	2¾

At highway and street crossings built comparatively recently in connection with separation of grades, if the railroad company has no record of the division of expense between the railroad and the public, only that portion of the cost of the structures and appurtenances should be included in the valuation that the railroad is called upon to maintain or that forms an integral part of the roadbed of the company.

TABLE 2—ANNUAL DEPRECIATION OF PASSENGER CARS

Type	Per cent
Milk and horse express........................	2½
Fruit express, steel underframes..............	2½
Fruit express, wooden underframes............	2¾
All other passenger equipment.................	2

Where the separation of grades has been effected under the provisions of State laws or by special agreement, and the proportion of cost thereof to the railroad in question is shown on its records, such recorded proportion of cost should be included in the valuation in lieu of the estimated costs above outlined.

As a rule the valuation of buildings should be based on their cubical contents taken from exterior measurements between the water-table and the roof. Where cellars exist their cost over ordinary foundations should be taken into consideration in fixing the price per cubic foot above the water-table. Where buildings are suitable for continued use their depreciation should be measured by the cost of repairs necessary to place them in 100 per cent condition to answer the purpose for which they are in use at the time of the valuation.

TABLE 3—ANNUAL DEPRECIATION OF FREIGHT CARS

	Construction		
Type	Wood	Steel underframes	Steel
Box	2	2	2
Stock	3¾	..	..
Coal and gondola.......	3	2½	2
Flat	3	2½	..
Refrigerator	2	2	..
Caboose	2½	2	..

ROLLING STOCK

Rates of depreciation on rolling stock should rest largely on the character of maintenance. Old locomotives still in use are rarely worth less than 25 per cent of their value new. The length of useful life of steam motive power is generally understood to be in reverse ratio to the boiler pressure. Passenger cars in regular service are frequently from 35 to 40 years old and may be reasonably assumed to be worth a minimum of 30 or 40 per cent of their value new. Freight cars well maintained may live more than 30 years, and their scrap value approximates 25 per cent. From the foregoing the accompanying annual depreciation tables may be derived, subject to adjustment to meet the different conditions encountered.

TABLE 4—ANNUAL DEPRECIATION OF WORK EQUIPMENT

Type	Per cent
Wood cars	2¼
Steel cars	1¾
Locomotive cranes, derricks, plows, flangers and workmen's cars	1½

FLOATING EQUIPMENT

Floating equipment of roads connecting the Great Lakes and tidewater may be divided into the following types: (a) Steel steam vessels on the Great Lakes, (b) steel steam vessels for tidewater service, (c) steel barges, car floats, etc., for tidewater service and (d) wood tugs, barges and miscellaneous, for tidewater service.

Progressive percentages of depreciation are proper, as shown in the accompanying diagram, all on the basis of regular annual expenditures for proper upkeep, but not embracing extraordinary expenditures for new boilers, new houses or new equipment like electric-light plants or steam steering gear.

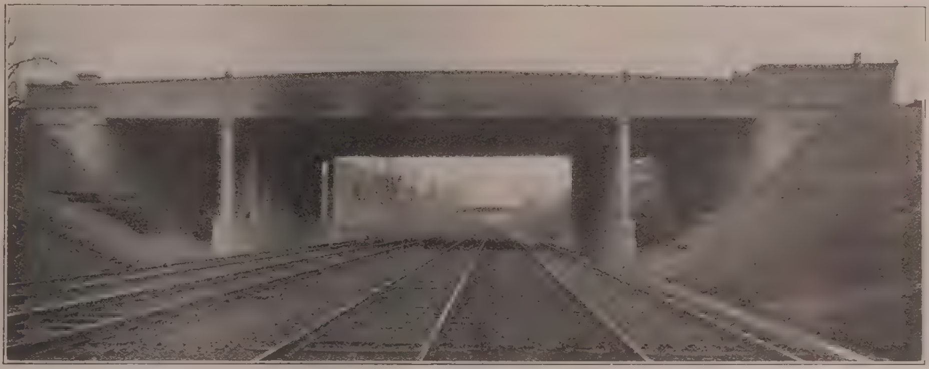
[Among the twenty-five forms accompanying the report and used by Mr. Wilgus on the Lehigh Valley work, those presented are selected as typical. One of these forms, as the specimen half-page suggests, brings together all elements of the permanent way according to the Interstate Commerce Commission classification, but does not include equipment. There are seventeen pages of the type shown—right-hand pages, with the opposite left-hand pages reserved for remarks. There are also several pages of cost data, and an index, the form containing in all forty-five pages.

With the report are also forty-eight sheets of diagrams and tables of quantities for railroad valuations, to facilitate calculations of earthwork, masonry, track material, pipes, etc. These are derived in part from Lehigh Valley standards and in part from other sources, and are prefaced by the statement that "where necessary, modified tables or diagrams should be prepared to suit the practice of the railroad that is being valued; and in instances where a structure as built does not accord with the practice upon which the diagram or table applying thereto is predicated, the quantities should be obtained by calculation from field measurements or from the company's records."—EDITOR.]

Plate-Girder Bridge Entirely Incased in Concrete

Clearance Requirements at Street Crossings Necessitated Cantilever Structure with Shallow Girders

IN order to keep the street grade in Philadelphia as low as possible and to give the maximum underclearance for trains on the four tracks on the Philadelphia, Baltimore & Washington Railroad below it, the eight lines of plate girders for the Sixty-fifth Street bridge were designed as cantilevers, with a suspended center span having much shallower girders than could otherwise have been secured. All of the girders, together with their cross-bracing, columns, handrails, and, in fact, the entire steelwork, were completely incased in concrete, which, although not ornately treated, gives the bridge a pleasing appearance and protects the steelwork both from corrosion and from the effect of locomotive gases.



Concrete-Incased Bridge over Railroad Tracks in Baltimore

The bridge has one 60-ft. main span and two 20-ft. side spans, all of them supported on single unbraced vertical H-beam columns in the planes of the longitudinal girders. The end columns are completely embedded in the abutment masonry and the two transverse bents of intermediate columns have their lower portions embedded in continuous thin transverse pier walls reaching up to a height of 4½ ft. above base of rail. Above this point they are inclosed in separate rectangular concrete casings with chamfered corners and circular cavities formed in a framework of horizontal 8 x ½-in. steel hoops 15 in. apart bolted to four 5/16 x ¾-in. vertical bars.

The longitudinal girders are about 9 ft. deep where they are fulcrumed on the pier columns with cantilever arms 13 ft. long spliced through a field-riveted web-and-flange cover plate to the suspended span girders, 34 ft. long and 5 ft. deep. The anchor arms, about 21 ft. long, are only about 2 ft. deep at the extremities, where they are riveted through hitch angles to the abutment columns. The top flanges are straight and the bottom flanges of the anchor and cantilever arms are curved to give the appearance of flat arches springing from the fulcrums.

The girders are transversely braced with the usual sway-brace frames of riveted angles at intermediate points, and over the pier centers are connected by vertical transverse concrete walls 12 in. thick.

The asphalt paving, 2 in. thick, was laid on a 1½-in. binder course supported on concrete arches 6 in. in minimum thickness at the crown, which are sprung between the longitudinal girders and entirely inclose their webs and both flanges. A 6-in. gas main and six 3-in. electric conduits are embedded in one panel of the floor. The two sidewalks, 13½ ft. wide, are supported at one edge by the outside line of main girders and at the other by a lattice girder handrail 7 ft. deep, which serves as a through fascia girder. These fascia girders are braced to the roadway girders by light transverse lattice girders incased in concrete and having their upper flanges embedded in the reinforced-concrete sidewalk slabs.

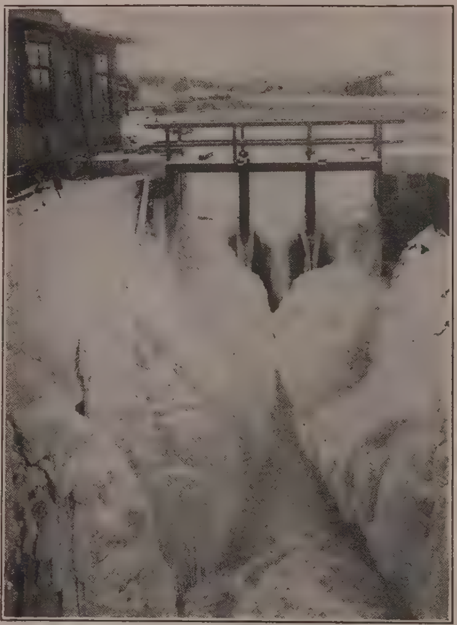
The bridge was designed by the bridge division of the Bureau of Surveys, Department of Public Works, of which Morris L. Cooke is director; George S. Webster, chief engineer, and James W. Phillips, assistant bridge engineer.

Winter Operation of Movable Dams

Experience Shows That Rolling Dams Are Superior and That Stoney Gates Cannot Be Operated at All in Very Cold Climates

MOVABLE dams of many types are installed at Trollhättan, Sweden, an industrial center like Niagara Falls. As the climate is severe—the station being located above the 58-deg. latitude—difficulties have been encountered in the operation of movable dams and gates during winter. As soon as the cold weather sets in ice forms around the gates, especially in the guides. The leakage adds to this formation, so that soon practically the entire back of the gate is covered with ice. Ice accessible with crowbars can easily be removed, while that at the bottom and in the guides must be thawed out.

In one case it was found that as soon as one part had been thawed out and the steam jet directed on another, ice began again to form, so that that method had to be abandoned. An attempt was then made to heat the gate itself (which was made of steel), but even this was a failure. Finally after two days' hard work the task was given up and the gate left to be thawed out when the weather got warm. This gate was of the sliding type. Stoney gates are even worse in this respect, as it is impossible to remove the ice formed in the roller nests. In the power canal for the 80,000-hp station there is a large Stoney gate for emergency use. As this gate is not installed for daily use, no record of its operation in cold weather is available.

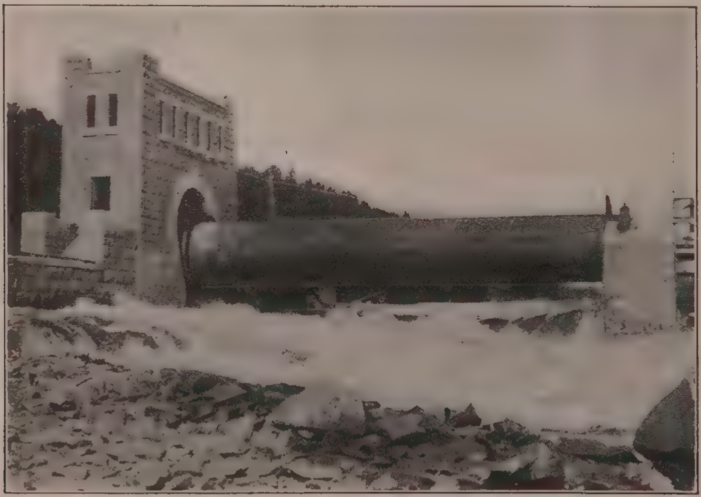

Ice Formation Around Sluice Gate

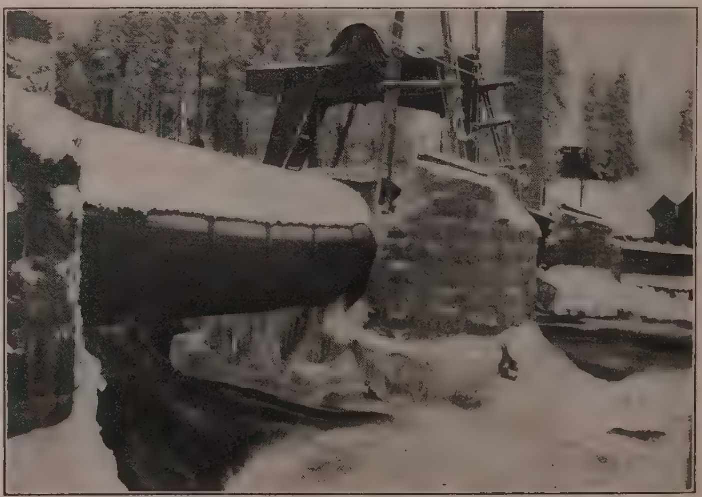
At the intake to the power canal there is a rolling dam consisting of two rollers 65 ft. 7 in. long and 13 ft. 1 in. high. No trouble has been encountered in keeping these rollers in operation during the winter and they are kept ice-free simply by placing coal stoves in each end of the roller. Experiments in heating them with electricity have been made, but the results have not been published. It is common practice to heat the racks at the turbine intakes with electricity. The frazil conditions in the river Göta Älf at Trollhättan are so severe that submerged telephone cables loaded down with lead have been coated with ice to such a thickness as to make them float to the surface.

Rolling Dam in Finland

A rolling dam installation consisting of two rollers 59 ft. 1 in. long and 11½ ft. high has been in operation at Ensokoski on the Wuochson River since 1907. They are installed for the purpose of power development, and as the location is slightly above the 62-deg. latitude the conditions in winter are even worse than those at Trollhättan. One of the accompanying photographs shows the formation of ice encountered below one of these rollers when it was desired to close the dam. The manager of the plant doubted that the dam could be operated, but after two hours' work with steam and crowbars, during which time the roller was kept heated by coal stoves placed inside of the cylinder, the dam was in operating condition.

Rolling dams installed in climates as severe as those referred to above are provided with ice-cutting gears at the ends so that no extra precautions need to be taken in keeping the racks clean.


Rear View of Rolling Dam at Trollhättan


Ice Formation at the Ensokoski Dam in Finland

Concrete Tower Wrecked

Fall of Wooden Hoisting and Chuting Tower Due to Narrow Base and Lack of Guys

DURING the recent construction of the baseball grandstand at Washington Park, Brooklyn, one of the three towers provided for hoisting about 7700 yd. of concrete to the forms was wrecked while being constructed under normal conditions. The tower, 6 ft. square and 86 ft. high, had 4 x 6-in. uprights braced in 6-ft. panels with 2 x 8-in. diagonals. It was erected by a subcontractor, who started the slender structure on the surface of the ground without an extended base and without anchoring the corner posts in pits. The tower was built up story by story, simply supported on the surface of the ground and without exterior bracing or guys, although it was intended to attach the latter when the tower was far enough advanced to receive the intermediate ones in their permanent positions. Just before this elevation was reached, when the tower was nearly one-half erected, it capsized in a sudden breeze, killing two men and seriously injuring one other.

The tower was rebuilt by the general contractor on extended sills seated in the bottom of the pit 5 ft. deep. Two other towers of the same character had been safely erected by the subcontractor and guyed with steel cables at the top and at an intermediate point about half way to the surface of the ground. Excavations were made under the sills of these towers and they were lowered into them, thus securing anchorages which increased their stability and enabled them to be used satisfactorily for hoisting concrete.

ON page 429 of the April 11 issue of this journal a review of the publication "The Testing of Barometers," issued by the U. S. Bureau of Standards, is incorrectly terminated with a reference to the Department of Agriculture. The book may be secured directly from the Testing Bureau.

How an English County Is Handling Its Road Problem

Surrey to Begin Asphalt Treatment of 400,000 Square Yards with Its Own Forces

HOW the county of Surrey, England, is preparing to deal with the problem of repairing and resurfacing its roads contains a wealth of suggestion for other communities, especially those surrounding large cities. In the preliminary report which has led to the county's decision to undertake road building by an organization of its own, the county surveyor, A. Dryland, drew attention to the growing burdens the development of the heavier forms of self-propelled traffic, such as lorries and motor omnibuses, were imposing upon the main traffic arteries of the county. He pointed out that during the last four years the number of heavy motor cars registered in Surrey had increased by 132 per cent, and in the county of London by 201 per cent, and that Surrey, being in all its parts within easy range of London, was subjected to increasing traffic of this nature. He alluded to the establishment of motor omnibus service extending from London for considerable distances into the county, and to other services being developed from local centers, such as Aldershot, Reigate and Guildford, with the likelihood of further developments of the kind.

Heavy Bus on Asphalt Surface in Kingston Vale, Surrey, England

These difficulties had led to careful consideration of what particular form of surfacing it would be wise to adopt for roads on which this traffic would, in the near future, render a change necessary, and Mr. Dryland had come to the conclusion that only the strongest and most durable forms of construction were likely to be economical, and that the tendency of the day was undoubtedly in the direction of dense asphaltic composition for a wearing surface. He suggested that if advantage were taken of local resources of sand and stone, and an organization were set up for the manufacture and laying of the material by the county council, the cost of work of this kind could be brought down by probably 20 to 25 per cent below the price at which the work could be done by contractors, and to such a figure as would be very little more costly than the less durable tar macadam.

The roads to be resurfaced include 500,000 sq. yd. of tar macadam, which was found to afford a suitable base for an asphaltic top, and 2,000,000 sq. yd. of water-bound macadam. If the whole of it had eventually to be changed, said Mr. Dryland, every cent per square yard saved in laying this large area would represent a saving of $25,000, and there was little doubt that probably 25 cents per yard could be saved on a large part of the area if an adequate and efficient organization were set up to carry out the work. It was pointed out in this connection that the council had many advantages over contractors in the carrying out of such work, inasmuch as they could probably obtain a free loan for the purchase of their plant, paying off the same on easy terms to spread the cost over a considerable period; they could locate the plant from time to time so as to be convenient for executing a large area of work, regulate their output to the circumstances, divert labor to some extent to other jobs in unsuitable weather, and would be free from many of the expenses of contractors in advertising, tendering for and supervising and maintaining isolated jobs, while the council could probably produce its raw materials in large quantities as cheaply, or even more cheaply, than a contractor.

It has accordingly been decided that the county shall equip itself with two complete sets of plants, one of a semi-portable nature for mixing the surface coat, and another of a more portable character for the base coat, the two sets costing complete $12,900. For the collection and distribution of the material there will be provided three motor lorries, costing about $3,700 each, and with a provision for contingencies, the total estimate for plant reached $24,000. With an estimated output of 12,000 tons per annum of the wearing surface material, this would amount to 40 cents per ton to be written off in five years. It is estimated that the base, the 1¼-in. wearing surface and side supports will cost about $1.10 per square yard complete, which is more than 25 cents per square yard less than any quotation from a contractor for similar work.

The work immediately to be done comprises about 26½ miles, or an area of nearly 400,000 sq. yd., and the work will probably take the greater part of three years to execute. With regard to the nature of the proposed surfacing, it has been found that there is an ample thickness of crust on all the roads on the east side of the county, and that probably a carpet coat only of the surfacing material, about 1½ in. in thickness, would meet with success; but, looking to possible future developments of traffic, it was thought wise to be on the safe side, especially where so large a sum of money was involved, and it was therefore recommended that provision should be made for side support to the crust, and that a bituminous base coat should be formed as well as a surfacing coat, the former being of a consolidated thickness of 2 in. and the latter 1¼ in., making a finished thickness of 3¼ in. of bituminous material.

Contracts for the county's plant equipment have been made with T. G. Marriott, of Fulham, London, S. W., and the county has engaged to purchase for its road work a minimum of 10,000 tons of Trinidad asphalt.

Smoke Abatement in Denver

Abstract of Report by Frank E. Shepard to the Art Commission Suggesting Control of Nuisance

THAT Denver is likely to lose her reputation as a city of magnificent mountain panoramas and clear skies because of smoke emitted by its increasing number of chimneys is the belief of Frank E. Shepard contained in a report recently transmitted by the art commission to the city council. That definite action may be undertaken the following measures are asked by the council: Appointment of three mechanical engineers to serve without pay as advisers to the smoke inspector; reference of new plans or changes of boiler plants to the smoke inspector for approval before a building permit is issued; examination and license of firemen; recording and inspection of boiler plants and development of a system of observations and record for violators.

The statement that an increase in manufacturing must necessarily mean an increase in volume of smoke is now known to be a fallacy. A chimney issuing dense volumes of smoke, formerly considered a symbol of industry, is now proved to be a symbol of inefficiency or ignorance.

LARGEST PLANTS NOT OFFENDERS

In Denver the largest power plant performs its work without the emission of smoke. One of the largest office buildings is now, after the installation of efficient devices and the adoption of improved methods, consuming about half as much fuel in 1914 as was required in 1904, under practically the same conditions of service. Modern methods of automatic stoking of coal in this same boiler plant are saving about 15 per cent over hand methods of firing, and at the same time greatly reducing the emission of smoke.

One of the city plants, at the county hospital, has been improved recently by the installation of a smoke-preventing furnace, with the result that the stack is now practically smokeless and the economy of the plant has been increased about 20 per cent.

An important influence in reducing the amount of smoke would be the improvement of methods followed by indifferent firemen. This requires official inspection and personal instruction and some means of checking the records of plants.

There are about forty switch engines operating in the railroad yards of Denver. The railways entering or operating in the city should be sufficiently interested in atmospheric conditions to warrant tests on at least one switch engine to determine proper equipment and methods for burning Western fuels without smoke.

Building a Reinforced-Concrete Outfall Sewer Limited by Tides and Clearance

Work at Vancouver, B. C., Done under Exacting Conditions as to Time of Construction, Grade and Strength of the Structure as a Girder

THE Victoria Drive outfall sewer at Vancouver, B. C., is required for the conveyance of a large quantity of storm water and sewage from a combined system into Burrard Inlet. The area tributary to the outfall has not yet been completely defined, pending decisions as to the location of other trunk sewers, but meantime it was very desirable to proceed with construction so that the wharf to be built over this sewer could be begun. The sewer was, therefore, built according to designs, which provided for a capacity sufficient to allow for extension of the drainage area.

The outfall sewer is 515 ft. in length and the section is practically the St. Louis standard horseshoe with a semicircular arch on a 4-ft. radius, walls 19 in. high, and an invert radius of 8 ft. 3 in. This cross-section of the sewer would not be required by the quantity of sewage to be handled, but the broad belt of low ground on the southern shore of Burrard Inlet at this point has compelled the lowering of the mains to a level which is only slightly above high water, and with the maximum grade that could be used (0.125 per cent) the necessary capacity could only be secured by increasing the width. On the other hand, on account of the necessity for carrying the sewer on piers across the tide flats, and the stresses to which it is likely to be subjected from heavy traffic before the fill to be made has thoroughly consolidated beneath it, it was necessary to give the structure sufficient depth to enable it to carry the wharf load as a continuous girder.

STRESSES IN SEWER BARREL

The future roadway to the wharf will give an earthfill over the sewer crown of about 5 ft. at the upper end and 1 ft. at the lower end. The concentrated live load for which the sewer is designed is a 15-ton road roller, or a 15-ton steam boiler on truck. The combination of dead and live loads led to a rather unexpected distribution of stress. It developed that for more than half the length of the sewer the gradual reduction of the earth load was a little more than compensated for by the increase in the live-load stress as the spreading action of the earth cushion diminished. The lower 200 ft., however, showed a rapid increase in stress as the cover thinned away. Two cross-sections were therefore adopted. A crown and invert thickness of 7 in. was maintained throughout; but the haunch thickness in the light section was made 13 in., and in the heavy section 17½ in. The intrados reinforcement in the arch and walls of the light section was made ½ in. square, and in those of the heavy section ⅝ in. square. The spacing of the intrados hoops was varied between 11 and 15 in. to suit the total stress in the haunch as found for the different parts of the sewer. The intrados was provided with separate reinforcing hoops, to guard against possible reversal of stress through dumping on one side when making the future fill for the roadway. These hoops are all ½ in. square, with a spacing of 13 in., and are lapped to the invert bars at both ends. Reinforcing bars are of twisted medium steel.

The sewer is carried on concrete piers, built in open excavation for almost its entire length. The height of these, and therefore the elevation of the invert, was fixed entirely by considerations of time. The level of the invert is slightly below that of ordinary high water and to lower this level appreciably would have resulted in very seriously shortening the working time on the invert, besides giving an opportunity for its reinforcement to acquire a greasy film and exposing the newly laid concrete to tidal wash before the initial set was completed.

Low-Tide View of Victoria Drive Outfall Sewer

A foundation of sound shingle was found immediately below the surface mud for a length of 160 ft. from the upper end. A bed of coarse, shelly sand then made its appearance and increased in thickness to 9 ft. at 350 ft. from the outer end. Until the 300-ft. station was reached, however, a reliable foundation could be obtained by excavating through this sand to the underlying shingle. Beyond this point it became necessary to drive 5 piles for every pier. These piles were afterward cut off at low-water level and inclosed in the concrete of the piers proper. All piers were given a width of 2 ft. so that the men tamping the concrete and laying the displacement stones inside the forms would have room to work. The width had to be increased to 2 ft. 8 in. in those piers sunk as open caissons in order to allow for the irregularities of the piles and removal of mud. All piers were made 13 ft. in length, so as to allow a margin of at least 12 in. on each side of the sewer. Apart from its service during construction as a support for the staging, this margin is expected to be of use in erecting the trestles for approach to the wharf. The piers are spaced 12 ft. center to center in the light section and 11 ft. center to center in the heavy section of the sewer.

REINFORCEMENT

The longitudinal reinforcement in the invert, which is of ⅝-in. bars lapped 60 diameters at joints, was designed to meet the stress produced by a bending moment of $WL/8$ with sewer full. A layer of triangle mesh reinforcement was placed on the top of the invert cross-bars. This is intended to prevent the formation of cracks during the period which must elapse before the sewer bottom receives the support of a consolidated fill below and also to guard against the effect of temperature stresses.

The upper bars of the longitudinal reinforcement are ½ in. square. It has been found that a smaller size is not stiff enough to hold the hoops in place during the tamping of the concrete. It is also considered that these bars are amply sufficient to carry the tension over the piers in the upper part of the sewer. A layer of expanded metal has been placed over the intrados hoops in the arch of the heavy section to reduce the risk of cracks forming as a result of the vibration set up by heavy traffic over the sewer where the earth cushion is no more than a foot deep. This layer is, of course, a safeguard against temperature stress as well. It was not thought advisable to multiply expansion joints, which might easily become annoying sources of seepage at some future time, besides breaking the continuity of the girder. One expansion joint was provided at the upper end; while the elasticity of the piers, which increased in height toward the outer end, is expected to be sufficient to take up the remainder of the movement.

WORKING BELOW LOW TIDE

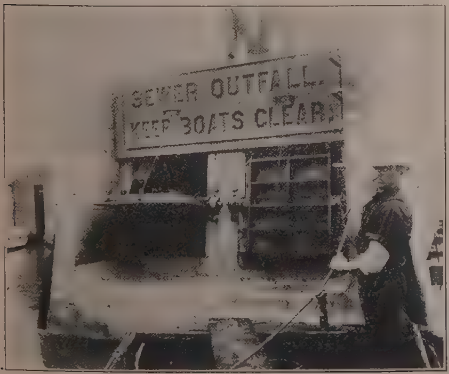
Advantage was taken of the spring tides of May and June last to get in all but the last eleven piers without the use of caissons. The workmen were used on the construction of the invert and arch during the neap-tide intervals. Each pier was brought up to low-water level in a single operation. The concrete mixer was set up on a scow which was moored alongside the work so that the material could be run into place at once through a chute, the displacement stones being dropped in from a low staging that was cantilevered from the last completed pier. As soon as the tide had fallen sufficiently the excavation was made by a gang of men working in high gum boots. The pier form was then set up, levelled and braced, and the filling proceeded with as rapidly as possible. It was possible to follow this method to the 400-ft. station by taking advantage of extreme tides.

The caissons used in the last eleven piers were built up of 3 x 12-in. lumber. No cutting plate was used on any but the last one, the cutting edge being simply chamfered. The lumber was dressed on the edges and spiked to 6 x 6-in. posts at the corners. The joints were covered on the inside with 1 x 6-in. strips and calked with oakum from without. Stout wire loops were put through the planks at intervals, ready for the attachment of cross-ties. Each caisson was built to stand about a foot above low water, the height required being found by probing, and was floated out and sunk on a falling tide, the piles having been cut off in the meantime at the lowest accessible level. When carefully located, a load of from 4000 to 8000 lb. of pig iron was placed on the top of the caisson and the water removed by a pump driven by a gasoline engine on a scow alongside. The mud was then removed as quickly as possible, the sinking of the caisson being hastened meantime by the blows of a heavy wooden mall. As soon as the caisson had been brought to a bearing and levelled, the wire cross-ties were put on and twisted up tight and the concrete and displacement stones run in. When the caisson was full the ordinary 2-ft. pier form was clamped on the top and the pier was continued to the level of the bottom of the sewer.

HEAVY PIER AT OUTFALL

The outermost pier is 5 ft. wide and has inclosed within it a 24-in. vertical pipe flared to the invert at the upper end and carrying a right-angled bend below, which will be connected to a line of 24-in. pipes laid on the bottom of the inlet. This line of pipes will furnish the passage for the dry-weather flow. Two cast-iron tidal flap valves at the outer end will give direct exit to flood water when necessary. These flap valves are protected by short wing walls of reinforced concrete, provided with newel posts of 6 x 6-in. angles held to the concrete by embedded bolts.

This outer pier was made wide so it could carry the outfall pipe, and also to protect the sewer from damage by collision with carelessly handled boats. Probings at this point showed a depth of 11 ft. of soft material, beneath which sandstone rock was reached 24 ft. 5 in. below invert level. This called for a caisson 20 ft. high, furnished with a cutting edge of steel plate 12 x ⅝ in., which was bolted to the lower planks. The caisson was made 10 ft. high to begin with. This was floated out and sunk exactly in position between two rows of guide piles. Additional planks were put on above as the sinking proceeded. The 24-in. cast-iron bend was placed next and the wedge-shaped transverse block of concrete molded around it, leaving two passages at the end of the caisson for men and material. The vertical length of 24-in. pipe was afterward gotten in, and more concrete run in around it. The weight required to sink the caisson was thus provided in a convenient form. No less than 75 tons of iron and concrete had to be added before the caisson reached bedrock.



Storm Water Tidal Flaps

Construction Near Shore End

The tidal flaps shown in the accompanying illustration differ from the ordinary type in being hinged at the middle. It was believed that a top-hinged flap of the necessary size would have required so considerable a pressure to open it wide that the flow in a sewer of such flat grade might be seriously hampered. The flaps in use can each be opened to the limiting position by a pull of 60 lb.

MATERIALS AND COSTS

It did not appear desirable to use a lower grade of concrete than 1:2:4 in the invert of the sewer, considering the stresses due to loading and the change of temperature to which it is liable. The necessity for quick setting and the possibility of some of the cement being washed out by the turning tide led to the use of the same concrete mixture in the piers. It was found possible, however, to use a good proportion of displacement stones in these. The sewer invert was lined with brick only in the manhole chamber at the upper end. The remainder of the invert was coated with a 1:2 mixture of cement and sand and troweled smooth.

COST OF 515-FOOT OUTFALL SEWER

Calculated hydraulic capacity, 245 sec.-ft.
Area equivalent to a 7-ft. circular sewer.

Item	Cost
Reinforcing steel	$1,387.00
Cement	3,550.00
Aggregate	2,210.25
Form lumber	998.20
Pile driving	251.80
Iron work for caissons	108.50
Tidal flaps and iron outlet pipe	278.60
Supplies	470.65
Material, total	$9,255.00
Labor (average cost $3.20 per eight hours)	7,020.00
Total	$16,275.00

or $31.60 per linear foot of the sewer.

The design and construction of the sewer were directed by F. L. Fellows, city engineer, and carried out under the personal supervision of A. G. Dalzell, engineer of sewers, the labor being done by workmen employed directly by the city.

WOODEN DECKS over subway excavations in New York streets are required, in the specifications for new contracts, to have a hard yellow-pine wearing surface so laid and supported and of such thickness that adjacent planks will not deflect separately when loaded. It is believed that this will preserve the tightness of joints and uniformity of surface.

Thin Arch Tunnel Subway Roof

Lining of Three-Piece Reinforced-Concrete Bents for Buenos Aires Tube

SEVERAL miles of subway are now under construction at Buenos Aires, as described in the Engineering Record of Nov. 29, 1913, page 613. A rectangular double-track structure has been built in open trenches which closed the street for traffic for very long distances. To prevent this street obstructon preparations are being made to build the subway by tunnel methods where the depth below the surface suffices. A concrete structure with a wide horseshoe shape cross-section for the double-track line was illustrated in the previous article. In order to avoid concreting a new type has been proposed and experiments are now being made to determine whether it shall be adopted.

In the new design the lining consists of three-piece transverse reinforced concrete bents, each consisting of two vertical wall posts with their upper ends united by an arch-roof segment. All three pieces have the same T-shape cross-section with the same dimensions; the section consists of an outside flange, about 2 ft. wide, and a vertical interior web. The upper ends of the verticals are inclined to make skewback seats, and all of the pieces are made of one part German Portland cement to seven parts river sand mixed in Ransome machines and reinforced by steel wire rods.

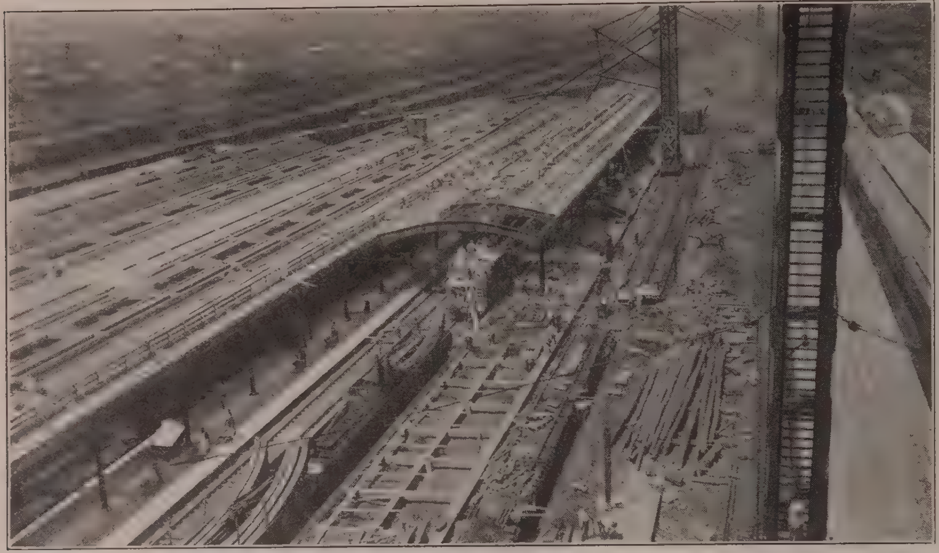
UNSUPPORTED CLAY ROOF

The excavation is made in clay so hard and uniform that the roof will stand without timbering even for double-track excavation. It was proposed to make the excavation slightly smaller than the neat lines and to trim it by means of a steel template having a slightly enlarged cutting edge to give clearance for the shield-like body. This template will be driven ahead through the completed rough excavation by hydraulic pressure and is expected to trim the sides and roof to a very smooth and accurate surface.

The vertical sections of each bent of the lining will be set up in final position as close as possible in the rear of the cutting template, and then the arch roof segment will be brought in, supported by hydraulic jacks on a truck. The jacks will be operated to force the segment against the corresponding roof surface, and it is expected that by operating them to secure a very slight penetration, complete contact can be obtained over the entire surface and the segments held in proper position for the skewback joints to be made with the side pieces. The transverse joints between the successive bents will be calked or otherwise closed and the lining grouted if necessary.

The subway is being constructed by the Cia de Tramways Anglo-Argentina Limitada, of which Mr. Ruchs is chief engineer and Mr. Fels is assistant chief engineer.

"THE World's Busiest Terminal" has recently been a subject of debate in the New York "Times." About 35,800,000 passengers per annum, including 18,800,000 local ferry passengers between New York and Hoboken, are handled at the Hoboken terminal of the Delaware, Lackawanna & Western Railroad, according to George A. Cullen, passenger traffic manager.



Erecting Short-Span Trainshed on Site of Old Terminal

Reconstruction of Jersey City Passenger Terminal Trainshed While in Service

Building under Heavy Traffic a Large Short-Span Steel-and-Concrete Roof on the Site of a High Arch-Truss Shed

DIFFICULT operations, numerous shifts of traffic, and very thorough advance plans for executing the improvements of the Jersey City passenger terminal of the Central Railroad of New Jersey have been necessary, in replacing the old facilities with new ones on the same site, to avoid interruption of almost continuous train movements and to insure the safety of millions of passengers using the terminal during its reconstruction. The improvements include the removal of the old steel-frame trainshed, the building of a larger trainshed and concourse on the same site, the remodeling of the head house or station building proper and the rebuilding of the ferry house and bridges, at a total estimated cost of about $2,000,000.

The train service at this terminal consists of about 185 trains each way in every day of twenty-four hours, making between 1200 and 1300 separate train or locomotive movements either into or out of the trainshed under construction. This service was maintained without any serious interruption, difficult foundations were built in the terminal, many thousand tons of material were handled over the heads of from 50,000 to 60,000 passengers per day without injuring any of them and the old structures were replaced by new ones in the same locations, some of them being of entirely different character and dimensions. The work has been done rapidly with a moderate amount of standard simple equipment.

ORIGINAL STRUCTURE AND CONDITIONS

The new terminal station, including the adjacent Express Building, occupies an area about 1500 ft. long to the end of the ferry slips on the North River, and 500 ft. wide, much of which was formerly occupied by the old terminal. At the east or river end there is water from 20 to 40 ft. deep in the slips, and the soil adjacent to them consists of mud and sand overlying a rock bottom from 50 to 100 ft. below low tide. Originally the whole site was a marsh with mud and sand extending to a great depth. When the old terminal was built, in 1887, the trainshed and tracks were carried on piles which were enclosed in a fill 30 or 40 ft. deep. The shed, about 225 ft. wide and 500 ft. long, covered twelve tracks, in addition to which there were two short tracks on the south side for occasional use. The roof had high pin-connected steel arches with a span of 142 ft. 4 in. supported on steel columns and carrying a central monitor and skylight. It was flanked on each side by a low lean-to with a span of 36 ft. 4 in., supported by the main arch columns and by an outside brick wall. Eight tracks were under the main trusses and two tracks under each lean-to.

NEW TRAINSHED

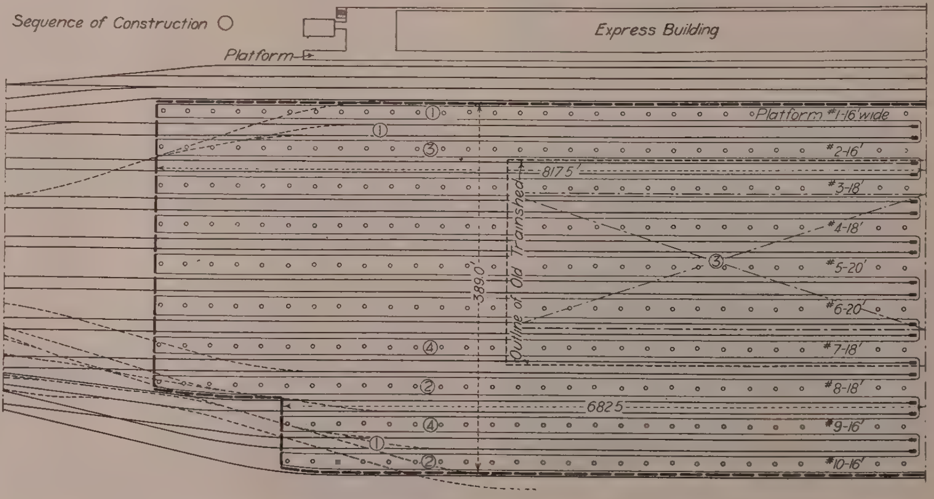
The 390 x 815-ft. trainshed is of the Bush type with short roof spans sheltering the platforms and tracks, and provided with skylights and ventilating ducts. It has a steel framework with concrete roof slabs and covers an area of more than 7 acres, accommodating an aggregate length of 15,550 ft. of tracks, with a total capacity of 250 standing cars (see Engineering Record of Jan. 4, 1913, page 6).

The tracks are carried directly on the surface of the fill, but the platforms and the steel framework of the building are supported on concrete piers about 6 ft. high with foundations of yellow-pine piles driven to rock and cut off 1 ft. below mean tide level. There are in the trainshed foundation about 4000 piles more than 50 ft. long, many of which are from 90 to 100 ft. in length, being made of two pieces spliced by a dowel pin and wrought-iron collar about 2½ ft. long. There will be in the finished shed about 14,000 cu. yd. of concrete made of Dragon Portland cement and Crescent sand and gravel. The roof slabs, 3½ in. thick, are made of 1:2:4 concrete, and there are about 2700 tons of steel in the framework.

SEQUENCE OF TRAINSHED WORK

In July, 1912, construction operations were commenced by driving piles and excavating for the foundations on both sides of the old trainshed, the platforms numbered 10, 9, 1 and 2 were successively built, and the roofs, with north and south trusses, were constructed above them. As these roofs were finished, new tracks were laid under them. These were placed on their final location, but were temporarily swung in at the throat end, connected with the existing ladders and interlocking system and put into service. Temporary sheds were erected and their east ends connected with the old station. In the second operation, the two short tracks south of the old shed were abandoned, platform 8 and roof 7 were finished, and the corresponding tracks put into service. In the third operation the old shed, with the exception of the north lean-to, was removed, and new platforms and roof construction advanced from south to north. In the fourth the lean-to on the north side of the old trainshed was removed, new foundations were built there and the platforms and roofs over them were constructed. The complete order in which platforms and sheds were built for the whole job was as follows: 10, 9, 1, 2, 8, 7, 6, 5, 4 and 3.

As already stated, previous to starting the new construction, twelve tracks under the old shed and two short uncovered tracks had been operated in the terminal. After the old shed had been removed and temporary wooden butterfly sheds erected to protect the tracks formerly sheltered by the old structure, the new tracks on each side of the old shed having by this time been connected up, the old tracks were abandoned, two at a time, to allow foundations to be built on their sites, which were



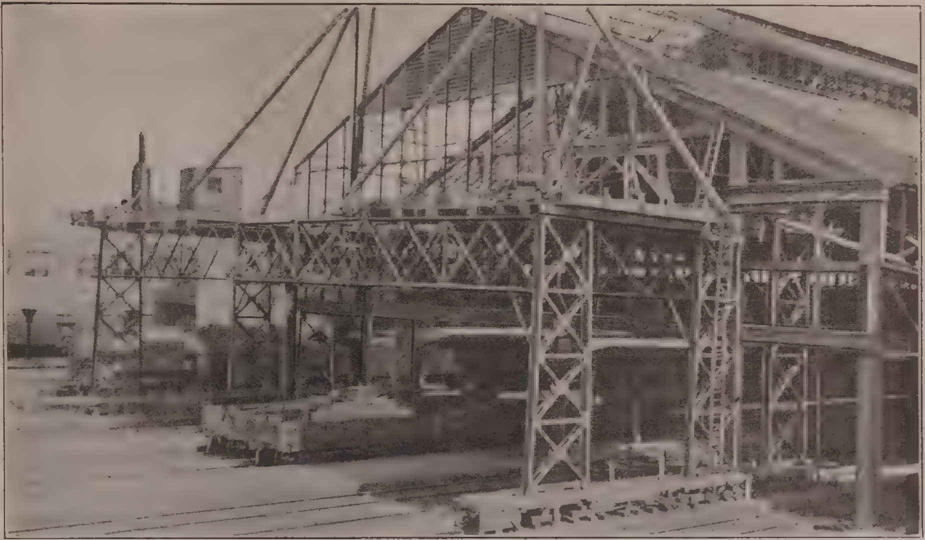
Plan of New Trainshed, with Numerals Showing Sequence of Construction Operations entirely different from the old sites on account of the introduction of wider platforms. More new tracks had, however, been provided than were needed to compensate for the old ones put out of service, so that at no time were there less than sixteen tracks in use, while on holidays as many as seventeen and nineteen tracks were available, thus giving considerably increased facilities for handling the regular business while the new construction work was going on.

Excavating, Pile Driving and Concreting

Excavations for the foundation piers were made both by hand and by locomotive cranes. Very little sheeting was done; the excavations were drained by hand diaphragm pumps and by two gasoline pumps mounted on wheels and shifted from place to place as desired. Piles were driven at the rate of nine or ten per day by each of two tall tower machines, one equipped with a drop hammer and the other with a steam hammer.

On account of the limited field in which work could be done, no storage for sand, gravel, and cement could be provided on the ground. The aggregate was therefore delivered on scows along the bulkhead south of the yard, and stored on the bank or was loaded upon cars, brought to the work and used directly from the cars.

At first the aggregate was transferred from the scows by small buckets which were raised and taken ashore by a "telegraph line," using an ordinary marine pile driver. However, this proved very expensive and a Brownhoist locomotive crane was purchased, which transferred the material direct from the scows to the bank, or to cars, at a much reduced cost.



Removal of Old Trainshed by Derricks on Signal-Bridge Traveler.

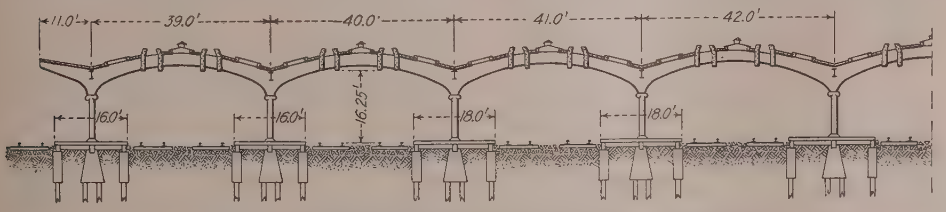
On account of the work being so much spread out, the concrete mixers were mounted on flat cars, which were easily pushed from place to place, and the sand and gravel were wheeled to the mixer from cars alongside. For the piers, girders and platforms the concrete was deposited by chuting direct from the mixer.

The concrete in the shed roofs was mixed in another movable plant, similar to that described for the foundation work, except that the mixer delivered to an Insley plant with a wooden tower 82 ft. high installed on a flat car. The tower had a 32-ft. and a 30-ft. boom supporting three steel chutes, which, with knuckle joints and an aggregate length of 70 ft., commanded a wide area. The tower was easily moved by hand, and the whole concrete plant was often moved 100 ft. or more during the noon half-hour. With this plant from 60 to 90 yd. of concrete were placed in the thin roof slabs in one eight-hour shift by a total force of about thirty men. The supply cars and concrete car were moved several times a day if necessary, a drill locomotive and crew being constantly available for the construction work.

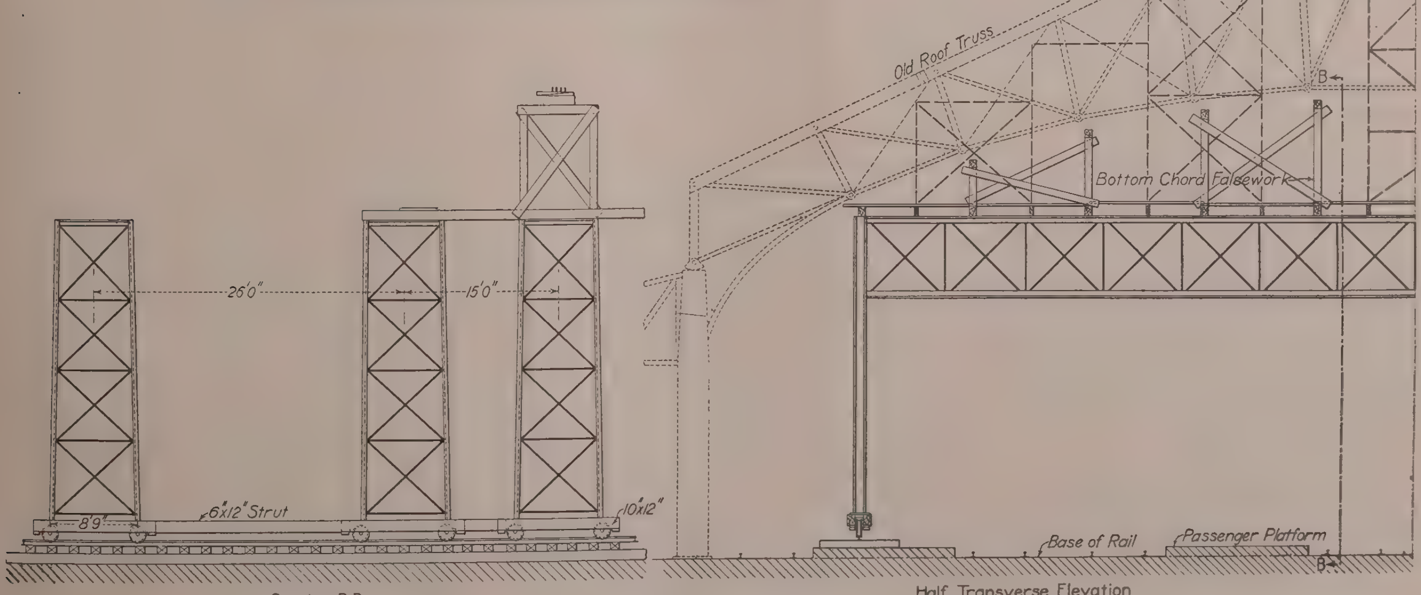
Trainshed Traveler

The old trainshed roof was removed by a traveler 110 ft. wide and 50 ft. long, mounted on double-flanged wheels running on two single rails 109 ft. apart, laid on the old passenger platforms. In the construction of the traveler three Central Railroad of New Jersey standard eight-track steel signal bridges were utilized. Each of them consisted of a pair of riveted trusses 8 ft. deep, 108 ft. long, and 8 ft. apart, mounted on a two-post steel bent at each end, and stiffened by transverse knee-braces to the vertical posts.

These bridges were braced together 15 ft. and 26 ft. apart longitudinally, and their



Part Transverse Section of New Short-Span Trainshed



Section B-B

Half Transverse Elevation

Signal-Bridge Traveler and Falsework for Removal of Old Trainshed Arch Trusses tops were covered with a horizontal plank floor 32 ft. above the platforms, with a clearance of 24 ft. under the bottom chords. Six wooden falsework bents conforming to the curve of the bottom chords of the roof trusses were seated on the forward bridge, two stiffleg derricks with 50-ft. booms were installed on the center bridge, and two double-drum hoisting engines were placed on the rear bridge directly over the bents. The traveler, with its equipment, weighed about 100 tons, and was installed at a small direct cost.

REMOVING OLD TRAINSHED

The traveler began operations at the west end of the trainshed. The successive roof trusses were wedged up on the falsework bents above mentioned, and were disconnected and removed, the derricks delivering the members directly to cars on the tracks under the traveler, while trains also passed under the traveler and on both sides of it, and traffic was maintained in the entire trainshed.

The solid floor on top of the traveler afforded protection to the passengers on the platforms below, and additional shelter for them was provided by temporary wooden butterfly roofs built over the platforms as the old roof was removed. Additional safeguards were secured by the use of heavy canvas suspended between the trusses to intercept any rivets, bolts or other small pieces falling from the roof when the latter was removed and the different members were disconnected.

The old trainshed trusses, sixteen in all, and weighing about 15 tons each, were removed between April 8 and June 12, 1913, and afterward the traveler was taken down and loaded for shipment in less than two hours. The plant for dismantling the travelers was the same as that used for putting it up, namely, two locomotive cranes, one at each end of each bridge to pick it up, run out with it to the west end of the shed to clear the temporary butterfly sheds and then lower it. Here a roadway wrecking crane picked the bridge up in the middle, swung it around, and loaded it on flat cars while the cranes were bringing out the next bridge.

On account of difficult traffic conditions for which provision could not be made in advance, practically all this work was done on a percentage basis. The new trainshed was built by R. P. & J. H. Staats, of New York City, and the old shed was removed by the Terry & Tench Company, Inc., also of New York City. This work, together with that on the concourse, head house, ferry house, slips and bridges, was executed by an average total force of from 800 to 900 men, working two shifts part of the time on some of the work, and with a large amount of overtime on all the work. The weekly payroll varied from $12,000 to $14,000.

The work was done under the direction of the engineering department of the railroad, of which Joseph O. Osgood is chief engineer, A. E. Owen, principal assistant engineer; J. J. Yates, bridge engineer, and C. M. Titsworth, assistant engineer in charge.

THE LOOSE-PAPER NUISANCE is attacked in an appeal to the citizens of New York City from the Department of Street Cleaning, urging the passage of an ordinance carrying stricter treatment of offending property holders.

San Diego Water-Rate Case

Abstract of a Decision by the Railroad Commission—Of Far-Reaching Importance to Public Utilities in California

WHAT is considered to be one of the most important decisions rendered by the California Railroad Commission was handed down April 28 in the case establishing rates to be charged by San Diego for water to consumers outside of the city limits. In reaching a decision Commissioner Max Thelan, who wrote the opinion, took into account the city's outside customers, the value of the property, the rate of return, depreciation, operation and maintenance, and finally the rate to be charged. Notes taken from the decision follow.

On Feb. 13, 1913, the city acquired from the Southern California Mountain Water Company certain property, but not all. The portion remaining in the hands of the company, including the Morena dam, was leased under option to purchase at a fixed price. In taking the property the city assumed the previous obligations of the company to consumers outside of the corporate limits of the city, which is considered by the commission a public utility. Disputes arose charging the city with discriminatory rates, and the council directed the city attorney to proceed before the railroad commission to have it fix the rates. The customers included distributing companies operating under existing contracts, farmers using water for irrigation under right-of-way contracts and other private parties. Rates varied from 6 to 25 cents per 1000 gal.

In valuing the property there were considered original cost, reproduction value new, depreciated reproduction value and value for purposes of rate-making. Fortunately, the original cost in detail was obtainable from the books of the water company. That portion sold to the city for $2,500,000 cost $2,260,468.55, while the Morena property, on which the city has an option to purchase for $1,500,000, cost $893,696.85.

INTEREST DURING CONSTRUCTION

Considerable attention was given at the hearing to the question of interest during construction. It appears, according to the opinion, that the amount shown for interest on the books of the water company represents only interest on borrowed money and that no entry appears on the books to represent interest on money secured through other means, such as the sale of stock. It is, of course, clear, stated Mr. Thelan, that the interest during construction should be allowed on all moneys from whatever source secured, which were spent for capital account during a reasonable construction period, and it is equally clear that no allowance can be made under this head for interest after construction has ceased and operation begun, and that that allowance can be made only for a reasonable construction period. For instance, if a dam can reasonably be constructed in five years (as a matter of fact there were such delays and such mismanagement that it took twenty years to construct the dam), it would not be reasonable to allow interest during construction for a period in excess of five years. Likewise, if the dam was constructed in five years and the plant was in operation ten years thereafter until the time of the fixing of the rates, it is clear that interest during construction should not be allowed beyond the end of the five years, and that no allowance can be made under this head during the ten years of operation. It appears that work on the Morena dam was commenced in or about June, 1906, and was prosecuted for about two years, and that thereafter during a period of about eleven years practically nothing was done. The work was resumed in 1909 and completed in May, 1912. Although one of the witnesses for the water company testified that the period of sixteen years was a reasonable period for the construction of this dam, notwithstanding the eleven years of inactivity, very little weight can be given to this testimony.

DEVELOPMENT EXPENSES

In establishing a value based on the original cost, some allowance must also be made, according to the decision, for the cost of developing the business. In ascertaining the amount to be allowed under this head, it does not seem reasonable to include anything for the period during which the different portions of this plant have remained idle after they were constructed and ready for business. After operation commenced, however, it would seem proper to make some allowance for such deficit as there may have been below a reasonable return on the money invested. In this connection, however, consideration must be given to the operating profits of the water company subsequent to the year 1906, and also to the fact that if the owners of the water company for the purpose of assisting in the development of the city of San Diego, and particularly of their own large property holdings there, saw fit to enter into a contract to sell water to the city of San Diego for 4 cents per 1000 gal., this being considerably less than the cost of the water, it does not seem reasonable to charge up the entire loss to the cost of developing the business. Such allowance will hereinafter be made for the cost of developing the business as under all circumstances seems just and reasonable.

Before leaving the question of original cost, attention was drawn to the fact that a considerable portion of the money which was spent was lost through mistake or bad judgment, as is always the case to a greater or less extent in large projects. A large portion of the original fill of the Morena dam was later torn out, involving a loss of at least $25,000. An additional $15,000 was spent when the plant was rehabilitated in 1909. The work on the lower dam at the Barrett site is of no avail, and more money and time than were necessary have been spent in exploration at this point. Attention should also be called to the fact that the Morena reservoir has never been used in its full efficiency, and that the safe yield of the impounding system as now determined by the commission's hydraulic engineers and by the city's hydraulic department is considerably less than was originally claimed for it by the water company's engineers. While a public utility certainly should not be penalized for its honest mistakes, attention is simply drawn to these matters lest it be thought that they have been overlooked and that proper consideration may be given to them in establishing the value of the system for the purpose of rate-making.

This case illustrates clearly, held the commissioner, the tremendous importance to the people of the State of the claim made by certain water companies and other utilities that the value which adheres to the water which they convey to their customers belongs to the utility and that the utility is entitled to capitalize the full value of that water, entirely irrespective of the cost to the utility, and to collect a charge for water high enough to yield a return on such amount as the utility's experts estimate to be the value of the water or the water right.

WATER-RIGHT VALUES

Attention is drawn to the grave consequences which may follow if the theories of value of water rights urged by various public utilities before this commission are adopted. If it is true that the entire value of the water which a public utility secures by appropriation or otherwise belongs to the utility, and that the public must pay rates on such value, it follows that where there is only one source of water supply for a municipality the water utility has the right to capitalize the entire life of the municipality. And in any case the utility will have the right to take for itself the entire increased value of land due to the placing thereon of water, entirely irrespective of the fact that the people of the State have given to the utility the right to appropriate the water, and that the actual price paid for the water may have been absolutely insignificant as against the amount claimed by the utility. In this case, for instance, it appears that although the value claimed for water rights by a witness in behalf of the water company was almost $3,000,000 and the real value of these water rights, as claimed by the same witness, was more than three times this amount, all that was actually paid for water rights as distinguished from land was $12,500. No figures, according to the opinion, could more forcibly illustrate the gravity of this problem and the dangers into which some of the courts are rushing the people of the State.

Confronted by the claims of companies holding existing contracts, the commission plainly held that the principle on which the commission has relied in these cases is simply that no public utility can by any contract which it may enter into in connection with its rate or service as a public utility take itself from under the supervision and regulation of the constituted public authorities. Discrimination by a public utility is none the less discrimination because it is effectuated, or attempted to be effectuated, by means of a contract. There is no magic in the simple transfer of public-utility property from one utility to another, authorized by the commission, so that property one moment subject to public regulation becomes the next moment free from regulation.

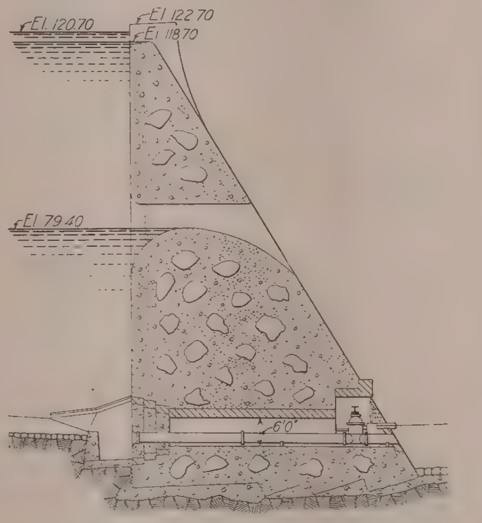
CONSUMPTION IN 1913

Of the water consumed in 1913, 92 per cent was used in the city of San Diego and only 8 per cent outside of the city. It would, accordingly, seem fair to charge to the outside consumers 8 per cent of the charges against the impounding system, but no portion of the charges against the distributing system within the city. To ascertain the average charge for water arising out of the construction, maintenance, operations and depreciation of the impounding system, the total annual charge should be divided by the total number of gallons which went through the impounding system and which were used by the consumers, giving the sum of 9.73 cents per 1000 gal. In order to provide a fair rate as between the different classes of consumers, it must be borne in mind that the relative expense of serving a small consumer is larger than the expense of serving a large consumer. Hence, a minimum of $1.25 for 5000 gal. per month was fixed. Between 5000 and 20,000 gal. the rate is 15 cents per 1000 gal.; between 20,000 and 1,000,000 gal. 10 cents, and for amounts over 1,000,000, 9½ cents per 1000 gal.

Wölfelsgrund Dam

A Flood-Prevention Structure with Unique Water-Discharging Facilities

THE Wölfelsgrund dam is one of the structures erected for flood-prevention and river-regulation purposes in Prussian Silesia. It is located on Wölfelsbach, a tributary to the Glatzer Niesse. Its relation to other reservoirs in that district was set forth in the Engineering Record of July 19, 1913, page 72. As the drainage basin is a mountainous region, the Wölfel is subjected to rapidly rising floods. It was, therefore, found necessary to create a large reservoir with a dam 100 ft. high.



Cross-Section of Wölfelsgrund Dam

Records of river discharges show that while the normal flow at the site of the dam is 35 sec.-ft., floods 3160 sec.-ft. are not infrequent. During dry seasons a discharge as low as 7 sec.-ft. has been recorded. As the drainage basin comprises only 9.65 sq. miles, the runoff per square mile varies from 328 to 0.73 sec.-ft. Obviously it was necessary not only to prevent floods but also to increase the low-water flow.

A reservoir was built having a maximum capacity of 31,000,000 cu. ft., of which 725,000 cu. ft. lie below El. 79.40 and are available for the development of power. Measured from the foundation to the crest of the spillway the dam is 95 ft. high, its crest length, 367 ft., and the thickness at the top of the non-spillway portion 10 ft. The maximum depth of water back of the dam is 82 ft. As this dam is used for flood prevention, low-water regulation and power development, its spillway arrangement is somewhat unusual.

Near the base of the dam there are two 2-ft. steel pipes, one of which is to be used for draining the reservoir and the other for the eventual development of power. About 43 ft. above the bottom of the reservoir is placed an arched opening capable of discharging 1240 sec.-ft. under a head of 59 ft. This discharge is the maximum that can safely be carried by the river below the dam. As a factor of safety for the structure a spillway of 1920 sec.-ft. capacity has been provided at the top of the dam.

Below the dam is a water cushion 8 ft. deep, designed to deprive the water of its scouring tendency. Including the clearing of the reservoir, real-estate purchases, etc., the cost of the reservoir was $125,000, or about $4000 per 1,000,000 cu. ft. capacity. The dam, which is made of cyclopean masonry and has a yardage of 26,200, cost $102,000. The reservoir was built during the years 1905 to 1907.

Book Reviews

The port of Los Angeles, past, present and future, is discussed in a 158-page publication issued by the Board of Harbor Commissioners of the city of Los Angeles. The work is historical, statistical and prophetic. (Los Angeles, Board of Harbor Commissioners.)

A technical dictionary of the English and German languages has been issued by the C. N. Caspar Company, of Milwaukee, Wis. The book, which is 4¾ x 6¼ in., comprises 264 pages and is divided into two parts, the first being the English-German dictionary and the second the German-English. The price is $1 net.

The Clarksburg (W. Va.) Waterworks and Sewerage Board has published a booklet containing the city's new sanitary-plumbing code, prepared by Scotland G. Highland, secretary and general superintendent. The code deals with methods of supplying water to buildings and of removing water and wastes therefrom. Practical details of plumbing and drainage are discussed.

The "Official Record of the First American Fire Prevention Convention" is being distributed. It includes all papers read and discussions raised at the convention held in Philadelphia Oct. 13-18, 1913, the 1913 report of the Philadelphia fire marshal, with the 1912 and 1913 reports of the Philadelphia Fire Prevention Commission attached; the 1914 report of the fire waste committee of the U. S. Chamber of Commerce and selections from "Fire Waste." (Philadelphia, Merchant & Evans Company. $1.)

Volume 8, No. 1, of the University of Nevada "Bulletin" contains the proceedings of the first annual Industrial Safety Conference, which was held at the university Jan. 26 and 27, under the direction of the department of mechanical and electrical engineering, co-operating with the Nevada Industrial Commission. Papers were presented by representatives of labor organizations, administrations of railroads, power and mining companies and the State commission. (Reno, Nev., University of Nevada.)

Published for the first time in 1912, the Good Roads Year Book has kept to its original purpose and stands as the leading index of road activities in this country. The 1914 edition is, however, more than a catalogue of laws and officials. It could be used to good advantage as a text in many engineering schools. Last year there were added to the original book chapters on road systems of foreign countries, National aid, Massachusetts specifications and patented methods of construction. The 1914 edition has been further enlarged by a statement of the funds available in all of the States for road improvements during the current year. The publication also includes, as usual, chapters on road expenditures in recent years, the work of all highway associations, dust preventives, convict labor and road legislation. There is also a list of bulletins, circulars and documents on highway work. The standard adhered to and the improvements made reflect credit upon the editor, J. E. Pennypacker. (Washington, D. C., American Highway Association. $1.)

The "Proceedings" of the tenth annual meeting of the American Wood Preservers' Association, which was held in New Orleans in January, have been issued. As usual, the account of the convention, with the papers presented, which occupies the bulk of the 498-page cloth-bound volume, is preceded by the constitution of the society and a list of the names and addresses of the members. The last seventy pages, except those taken by the index, are given to statistical data bearing upon the quantity of preservatives used in 1913, the number and location of plants and the amount of wood treated. (Baltimore, Peters Publishing & Printing Company.)

New and expanded editions have been issued of the "New York Highway Commission's Instructions to Employees" from the office of George A. Ricker, first deputy commissioner. Volume 1 covers general instructions, construction work, maintenance and repair. Volume 2 covers service and office work. Although a great deal of the information in these booklets pertains to the duties of various officials and departments, there is considerable information of use to contractors. This is especially true as to methods of estimating and keeping costs, and this data would alone suggest to those who are concerned in road building the desirability of obtaining copies of these very useful publications. Another thing that is suggested by a reading of these pamphlets is the enormous amount of detail involved in the administration of so huge an undertaking as the building of the New York State highways. When the proportions of this task are considered, cause for wonderment that some things in connection with it have gone wrong disappears. (Albany, N. Y., State Highway Department.)

Industrial Arts Index—1913. By Potter and Teich. Buckram, 7 x 10 in.; 326 pages. White Plains, N. Y., H. W. Wilson Company. $7 net.

This is the first volume of a new scheme for indexing current technical literature. During the year the index is issued every two months and each successive issue contains all that was in previous issues for the year, as well as the references to articles which have appeared in the last period; in other words, it is cumulative with each issue for a full year.

Comparison of this new venture with an index which has been published for a number of years is inevitable. The new index differs principally from the old one in that it follows the natural classification rather than the highly artificial one used by the older index. Take, for example, the subject of "Tunnels." In the new index one turns directly to the word tunnel under "T," as in a dictionary or encyclopædia, and there finds all the references. The old index is subdivided into main headings denoting the various fields of engineering. These fields are again divided, and not until the third subdivision does alphabetical classification begin.

The new publication contains references to articles in about fifty technical periodicals, as against 200 in the older publication, although the number of references in the new index appears to be, roughly, 65 to 70 per cent of the number of those in the older one. The periodicals indexed by the new index are fully representative of the American field, but no foreign periodicals are included. It is probably safe to assume that subsequent issues will show improvements over this first volume and that the field under review will be broadened. There is probably need of rather more detailed indication of the contents and scope of the articles, which is a detail, however, that can easily be corrected, as the general plan is good.

Railroad Curves and Earthwork, Field and Office Tables. By C. Frank Allen, Professor of Railroad Engineering, Massachusetts Institute of Technology. Fifth Edition, Revised. Published in Two Forms: A, Two Parts (Text and Tables) in One Volume, Leather, 4½ x 7 in.; 516 pages; $3 net; B, Two Parts, Sold Separately, the First Part, "Railroad Curves and Earthwork," Leather, 4½ x 7 in.; 234 pages; $2 net; Second Part, "Field and Office Tables," 282 pages; $2 net. New York, McGraw-Hill Book Company, Inc.

(Reviewed by Arthur F. Comstock, Associate in Railway Engineering, University of Illinois, Urbana.)

Previous editions of this pocket handbook, beginning with the first one in 1899, have demonstrated that it is well suited to the needs of the student, as well as of the practising engineer in field and office. By revising and extending the chapters on turnouts, connecting tracks and crossings, and spirals, the author has filled a need which has been quite generally felt by the profession for several years. These, with other revisions, have perfected the entire text and tables to a degree that is certain to win general approval. Prominent attention should be given here to the excellence of typography, binding, and the other details of manufacture which characterize the book and which are so particularly appropriate and important in a work of this kind.

The first part of the book, the text—which may be had in separate binding if desired—consists of seventeen chapters well interspersed with figures. Chapters 1 to 7 inclusive, dealing with reconnoissance, preliminary survey, location survey, simple curves, compound curves, reverse curves and parabolic curves, have been only slightly changed. The various subjects and problems contained in these chapters are clearly and concisely presented.

Chapter 8 consists of twenty-five pages on turnouts, in which are solved the more common problems relating to the modern split-switch turnout and crossover, both for straight and curved track. This chapter has been almost entirely rewritten, bringing it abreast of modern practice. Chapter 9, treating of connecting tracks and crossings, has been augmented by a few pages devoted to additional problems.

Chapter 10 contains a twenty-two page discussion of the spiral easement curve, and has been largely rewritten and adapted to the standards of the American Railway Engineering Association. The underlying theory of the spiral is well explained, which fact, with the tables in the second part, makes the subject easily understood and readily applied in the field.

Chapters 11 to 17 inclusive, dealing with earthwork, have undergone little change from the previous edition. These seven chapters, comprising eighty-one pages and four two-page diagrams, give an unusually complete discussion of different methods of computing and staking out earthwork, besides explanations for constructing earthwork diagrams and tables. The chapter headings are: "Setting Stakes for Earthwork," "Methods of Computing Earthwork," "Special Problems in Earthwork," "Earthwork Tables," "Earthwork Diagrams," "Haul," and "Mass Diagram." The latter chapter contains fourteen pages of text and diagrams and includes all the essentials of the subject.

The second part of the book, which may also be had in separate binding, consists of 282 pages devoted to thirty-three tables, with explanations for their use. Naturally a number of the tables might be called standard, since they appear in somewhat similar form in most railroad handbooks. Several of the tables, however, are either distinct in character or are more complete than is often the case. Table 1 gives values of radii and their logarithms, varying by one-minute intervals of the degree of curve up to 9 deg., by two-minute intervals from 9 to 15 deg., by five-minute intervals from 15 to 20 deg., and by ten-minute intervals from 20 to 40 deg. In calculating the radii the author has adhered to 100-ft. chords for all degrees of curves, in conformity with the best practice. Table 3 is especially noteworthy in that it gives values of the tangent distance of a 1-deg. curve for each one-minute interval of intersection angle from 0 to 99 deg. Table 4 is complementary to Table 3 and consists of two facing pages showing the corrections to be applied in obtaining correct values of the tangent for any degree of curve up to 14 deg. by simple division. These two tables will save much time in the field, while giving absolutely correct results.

There are six tables relating to the spiral, based upon the standards of the American Railway Engineering Association, in which deflection angles are figured for ten equal chords comprising the spiral. From these tables and the explanations the field work of laying out a spiral may be readily done wherever this standard is in vogue.

The logarithmic tables are six-place throughout, accompanied by tables of proportional parts. The tables of natural functions are five-place. Table 22 shows the various dimensions of split-switch turnouts taken from standards of the American Railway Engineering Association. Other tables include a table for computing the difference between arcs and chords for radius = 1, table of velocity heights of trains, table of stadia reductions, and table of mean refractions in declination. The earthwork tables include one on the prismoidal correction as applied to results obtained from the tables calculated by end-area method.

To those familiar with previous editions it is unnecessary to say that the author has set a very high standard in this book. The revisions of the fifth edition have added much to its value, although increasing its size but slightly. For general purposes the text and tables bound in a single volume will be most satisfactory, although under special conditions either one or both bound separately may be desirable.

Letters to the Editor

Mechanical Interpolator

SIR: The making of an exact contour map is often considered a somewhat wearisome task, due to the fact that the contours must be interpolated between points, of which no two adjacent ones may be the same distance apart as any other two, either vertically or horizontally.

The fundamental consideration in choosing points in the field for making a contour map is, of course, so to select them that the slope of the ground between any two adjacent ones is uniform; then, when plotted, the contours may be interpolated horizontally in direct proportion to the difference in elevation. It is true that interpolation may often be made with sufficient accuracy, or consistently with the use to which the map is to be put, by judging the proportionate distances and interpolating by inspection. There are many cases, however, where this is inconsistent and undesirable. At best, it is unscientific.

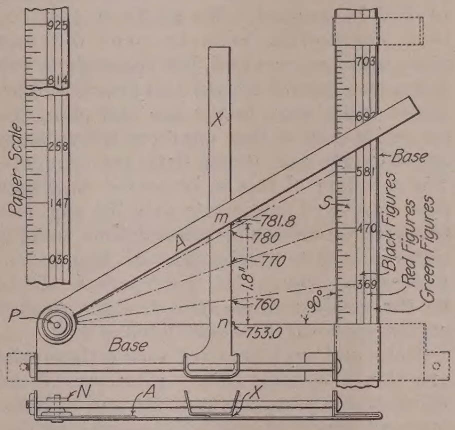
The writer always finds the making of a contour map interesting work and thoroughly enjoys the process of following the contour lines through their tortuous and unexpected courses. But the anticipated pleasure is often overshadowed by the tedious process of interpolation which precedes. This has suggested the invention of some ennui-saving device whenever a map has been attempted.

Doubtless the reader is familiar with devices for this purpose. One or two common forms come to mind. One is a parallelogram frame jointed at the corners, and having a series of strings stretched across at equal distances apart parallel to one side of the frame. The strings represent contours and the adjustment to fit different distances between points is accomplished by changing the angles of the frame, which in turn changes the perpendicular distance between strings. Another device is a rectangle drawn upon a piece of tracing paper or tracing cloth, and having lines ruled in one direction parallel to one of the sides. One corner of the rectangle is pinned over one of the points in question and the rectangle then rotated until the desired number of lines fall between this point and the second point. The contours are then located by pricking holes through the tracing cloth on the parallel lines of the rectangle and on a line joining the two points between which the interpolation is being made.

The writer quite recently had a large contour map to make in which the contour interval was 1 ft., and the scale 1 in. to 60 ft. Accuracy was a very important consideration and necessitated the locating of more than 1500 points in the field. Since it was necessary to make interpolations between all adjacent points, several times 1500 interpolations had to be made. To eliminate monotony and ennui, as well as to facilitate the work, the device shown in the accompanying cut and described below was invented.

The instrument is simple, but one similar to it has never come to the attention of the writer, so he feels that its description may be of considerable interest and value, particularly to those having to do with topographical work. Any engineer can make suitable paper scales, and with a pair of tinner's snips can cut out most of the remaining parts from any desirable thin sheet metal, such as tin, zinc or brass; or with a little care may make a less permanent one of stiff, tough paper.

In the instrument the writer used the base was laid out all in one piece, as shown in the figure, the dotted lines indicating the shape of the metal before being bent into final form. Loops were made at the right-hand side of the base for carrying the movable paper scale S, shown in place on the base and also at the right of the figure. An arm A, not graduated, is pivoted at the point P, this pivot being at the intersection of the line of the inner edge of A and the inner edge of the lower portion of the base. The arm A is laid on top of the base and held in place with a small screw provided with a thumbnut N which serves to clamp the arm in any desired position. Another arm X is mounted upon a rod about 1/10 in. in diameter running parallel to the inner edge of the base and about ¼ in. above the base. This arm can be moved from side to side, always parallel to the right-hand edge of the base, and its edge is therefore always parallel to the movable paper scale S. The rod passes through two holes in the bent-up projections of X. These projections are sprung into place so that the tendency to spring apart provides sufficient frictional resistance to keep the arm from sliding. Pressing the projections toward each other with thumb and finger releases the arm. The arm X is not graduated. This arm is added for completeness, and may be dispensed with, and good results still be obtained in contour work by drawing a temporary light line between the points in question, then setting the instrument by estimating a right angle between this line and the inner edge of the base.



Mechanical Interpolator

Three vertical columns of numerals are printed on the scale S to permit of the use of a shorter scale than could be used if only one row of numerals was given. These respective columns are printed in different colors to make it easier to follow the column when setting off the elevations.

To make clear the operation, assume that two points *m* and *n*, 1.8 in. apart, have elevations of 781.8 and 753.0 respectively, and that contours 760, 770 and 780 are to be located. The difference in elevation may be obtained by neglecting the 700 and subtracting 53.0 from 81.8. Set the movable scale S so that 53.0 is on line with the inner edge of the lower portion of the base, then set the arm A with its inner edge at 81.8 and clamp it. The row of red figures is used. Now shift the whole instrument and adjust X until the intersection of A and X comes at *m* and the intersection of X and the inner edge of the base comes at *n*. Holding the base in position, unclamp A and move it until the inner edge comes to 80.0 on the scale S. The intersection of A and X then locates contour 780. The dash lines indicate the successive positions of A to determine the contour points. Any other desired points may be interpolated similarly.

The theory is based upon proportional triangles and is so simple that further explanation is not necessary. The operation is very quickly performed, more quickly, in fact, than the number of movable parts would seem to permit, and requires much less time than the usual process involving the slide rule, a scale, some mental arithmetic and considerable apprehension as to errors. If there is any doubt of this in the reader's mind, it is suggested that the usual process be followed through in detail for the problem given above. Since no two adjacent points are likely to be of the same elevation and distances between points vary, new subtractions must be made, new distances measured, and new settings of the slide rule made for finding proportional parts every time a new pair of points is under consideration.

Accuracy and rapidity of interpolation, reservation of mental energy and elimination of the likelihood of errors, through the elimination of mental processes and manipulation of scale and slide rule—all conduce to relieve the monotony of the work and make the plotting of points a pleasure.

JAMES E. SMITH,
Assistant Professor of Civil Engineering,
University of Illinois.
Urbana, Ill.

Rules Governing Architectural Competitions

SIR: You may be interested in the conditions governing architectural competitions in Arizona.

Since 1901 the territorial and State laws have required public officers to secure plans and specifications for public buildings by competition. The provisions are contrary to the rules of the American Institute of Architects and are very much disliked by the majority of the architects that enter the competitions. The portions of the statutes which are of particular interest are as follows:

"(Section 1.) When by any statute of this territory power is given to any territorial or county officer or officers or to any board of supervisors or corporation, or any board of trustees or commissioners or other person or persons created or appointed by authority of any such statute, to erect or cause to be erected or constructed, any territory or county or other building or structure it shall be the duty of said officer or officers, board of supervisors, corporation or board of trustees, or commissioners, or other person or persons, to advertise for plans and specifications in detail for said building or other structure, and to state in said advertisement the amount authorized by law or otherwise to be expended for the erection of said building or structure; and also the premium to be awarded to the architect whose plans and specifications for the same may be adopted."

"(Section 2.) Whenever the plans and specifications of any architect shall be adopted, such officer . . . or persons so adopting the same, shall, before any premium shall be awarded for such plans and specifications, require such architect to execute and file with officer . . . or persons a good and sufficient bond, with two sufficient sureties thereto in the penal sum of $5,000, to be approved by such officer . . . or persons, as the case may be, and conditioned that within sixty days from the date of said bond, he will on presentment to him, enter into a contract containing such provisions and conditions as may be required by such officer . . . or persons; and also conditioned that he will give such further bond to secure the faithful performance of such contract, with such sureties as may be required of him, in the event that such officer . . . or persons so acting under authority of law should within sixty days require said architect to enter into such contract to erect such building or structure at the price named in the said advertisement to be expended for such purpose."

Section 2 provides, further, the manner of carrying out the contract in case it is awarded to the architect, and Section 3 provides that contracts entered into by public officers, in violation with the act, shall be null and void.

The premium which is usually allowed for the plans and specifications, obtained in accordance with the above law, is 3 per cent of the amount to be expended for the structure, the matter of superintendence often being separated from the award for the plans, although usually the successful architect is selected to superintend the construction. The total amount usually allowed for plans, specifications and superintendence is 5 per cent of the total cost.

The University of Arizona proposes to construct an agricultural building, to cost $150,000, for which competitive plans were received during the month of April. In this case the law was interpreted to mean preliminary plans in detail, which interpretation has, I believe, been made in the case of other buildings. Nineteen sets of plans were received, one of which was not eligible for consideration for the reason that the architect's name was upon the drawings, which was contrary to the rules governing the competition. All of the plans received were excellent pieces of work, and they were apparently all the work of skilled and experienced architects. The cost of the labor required for each set would undoubtedly be at least $300, which would make the total value of the work received by the university to be $5700. For all of this work and for the further work of preparing the detailed plans and specifications the university will pay the sum of $4500. It is apparent what a profitable occupation architecture would be if all work should be awarded in this manner. If every competitor should receive his proportionate share of the awards made, all would starve to death.

In a number of cases which have come to the writer's notice the clause requiring plans and specifications in detail has been copied verbatim into the advertisement, in which case complete working plans have been submitted. This adds further injury to the insult which is placed upon the competitors by the more liberal interpretation.

Under the conditions mentioned it should be impossible to secure a set of plans, but the writer knows of no case in which plans were not received. It would undoubtedly be an excellent thing for the national societies to formulate and recommend desirable laws as well as proper codes of ethics.

L. A. WATERBURY,
Professor of Civil Engineering, University of Arizona.
Tucson, Ariz.

Value of Complete Surveys

SIR: If the engineers of our country will give careful study to H. A. Petterson's last article on comparisons of systems for flood control, published in the Engineering Record of May 16, and adopt a platform of practice having for one of its main planks the second half of the last paragraph of Mr. Petterson's paper a good step in a forward direction will result. Too much emphasis cannot be laid on this paragraph, which really forms the keynote of the entire paper.

Only where complete data have been secured upon which to base an engineering project will the one best plan for that project be evolved. We all know that for most engineering projects many different plans may be conceived, but these plans will run a long gamut of cost and practicability. There will always be the one best plan, discoverable only to that engineer whose maps are accurate and whose data are complete. The corollary of this is, of course, that with poor maps and inaccurate data the engineer is forced to make some assumptions, and his plans will rest upon guesswork and be unworthy the name. His net result is apt to be the condemnation of a feasible project or the approval of a questionable one.

Municipal engineers are among those who are slowly coming to a realization of the value of complete surveys for use in planning all kinds of city engineering works. From such cities as Baltimore and St. Louis comes word that the complete topographic maps made of those cities, while large in first cost, are proving themselves invaluable, taking the place of all preliminary surveys.

Within the last two years the city engineer of Cincinnati has seen fit to make a precise and detailed topographic survey of that city as part of the work of the Division of Sewerage Investigations, preliminary to remodeling an already existing sewer system and planning extensive additions thereto.

A canvass of other cities, however, shows that much of the old spirit still exists—that the engineer is prone to regard money spent on detailed and accurate surveys as money taken away from construction work. This is not so. Money spent on accurate surveys is productive of such economy in the preparation of plans that the survey will really pay for itself in a very few years. And it goes without saying that it is in the cities where construction work is most difficult that accurate surveys are most needed and will be productive of greatest economy.

Washington, D. C. HUGH C. MITCHELL.

Design of Reinforced-Concrete Retaining Walls

SIR: On page 516 of your issue of May 2 there appears a letter by Edgar K. Ruth which refers to the "Design of Reinforced-Concrete Retaining Walls" as suggested by Donald N. Becker on page 86 of your issue of Jan. 17. It seems to me, from Mr. Ruth's letter, that he is under the impression that the weight of the wall does not reduce the amount of steel reinforcing required for bending only, unless the center of gravity of the wall falls back of the center of its base. I think the following simple illustration will show clearly that the weight of the wall does reduce the amount of steel required, even though the center of gravity of the wall may fall somewhat in front of the center of its base.

Suppose an empty box be set up and a weight attached at its top, as shown in the accompanying figure. If the weight of the box is neglected the tension in rod R will be Wh/b. Then suppose the box to be filled with sand. Is it not clear that the tension in R will be reduced so long as the center of gravity of the box falls back of the point A? In this illustration W produces an overturning moment which corresponds to that produced by earth pressure on the back of a wall. Point A corresponds to the center of gravity of compressive concrete in the wall and rod R to the steel reinforcing.

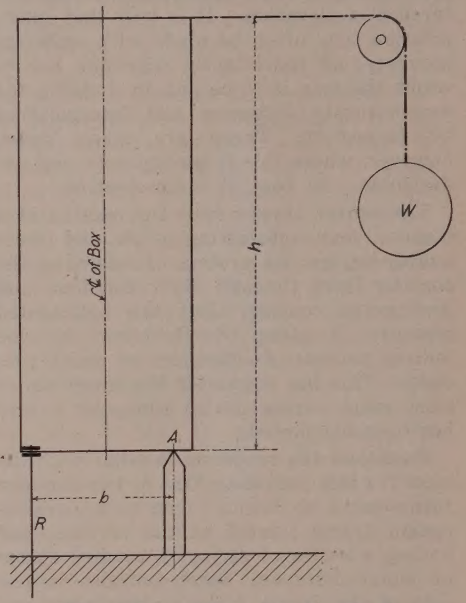
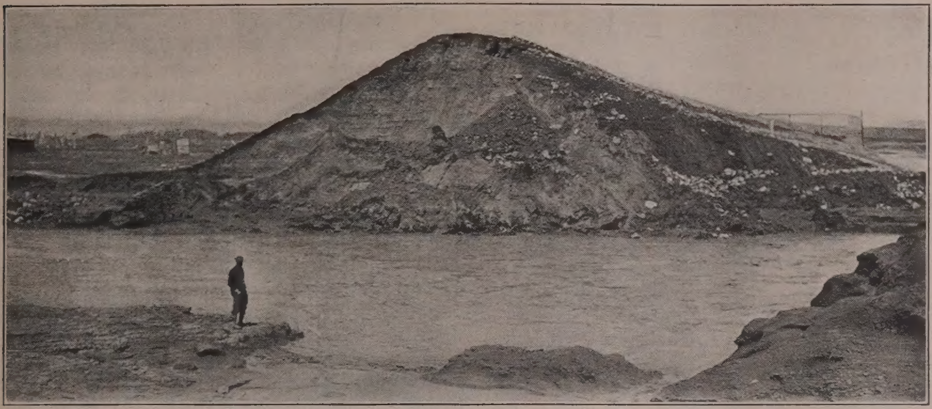


Illustration of Principle Involved

Since the center of gravity of compressive concrete is usually not more than from one to two-tenths the thickness of the wall from its face, Mr. Becker's solution will effect a saving in nearly all cantilever walls.

T. A. SMITH,
Structural Designer, Chicago, Milwaukee & St. Paul Railway.
Chicago.

TRIAL TESTS to determine the proper load for the concrete foundations of the baseball grandstand at Washington Park, Brooklyn, were recently conducted under the direction of the Department of Buildings of the Borough of Brooklyn. The site had at one time formed part of the bottom of the Gowanus Creek and has been filled in to a depth of 6 ft. above ground-water level with miscellaneous materials without stone. All adjacent buildings were supported on pile foundations, and it was assumed that the soil might support the unit load of 2½ tons per square foot allowed in Chicago. Three pits were excavated to a depth of 6 ft. and a 24 x 24-in. area at the bottom was loaded with pig iron. The bearing power of the soil thus indicated was such that the loads were reduced to 1¼ tons per square foot.



How the Hebron Dam Was Cut Away by Rush of Water

Hebron Earth Dam Washed Out

Failure of Reservoir Embankment in New Mexico Caused by Seepage of Water through Holes Made by Gophers or Other Rodents

By C. B. CASE
Chief Engineer, Maxwell Irrigated Land Company, Maxwell, New Mexico

BURROWINGS by gophers or other rodents are believed to have been the primary cause of the destruction of the Hebron dam of the Maxwell Irrigated Land Company at Maxwell, New Mexico, which went out May 2. Finding its way through one of these small openings, water began flowing through the dam, scoured out a large cavity and eventually washed away a section of embankment 200 ft. long. The dam is an earth structure 3700 ft. long, with a maximum height of 56½ ft. and an average height for 700 ft. across the creek bottom of 38 ft.; the average width of base for this section is 183 ft. The break occurred after a rainfall of from 6 to 10 in. during three days beginning April 29. The reservoir filled rapidly and water started to flow over the paved spillway on the evening of April 29, increasing steadily until the break occurred. The reservoir was emptied in 3½ hours.

The Hebron dam is situated on the Chico Rico Creek, about 1 mile above the junction of the latter stream and the Red or Canadian River. Its catchment basin covers an area of 350 sq. miles. The upstream slope is 3 to 1, paved with boulder riprap 1 ft. thick. The downstream slope is 1½ to 1 and the crest width 12 ft. A puddle trench 10 ft. wide on the bottom and from 18 to 34 ft. deep below the original surface was excavated at a point about midway between the center line and inner toe, and was carried 2 ft. into the clay substrata.

SPILLWAY AND OUTLETS

The spillway was paved for a distance of 700 ft. from the center line of the dam with 1 ft. in depth of boulder riprap, after which gravel concrete, mixed wet, was poured and tamped into the interstices and brought to a level 3 in. above the boulder riprap surface. At the center line of the dam the spillway is 203 ft. wide, 13 ft. below the top of the dam, and has a grade of 2 per cent for 200 ft., after which the grade is reduced to 0.7 per cent. On the center line of the dam a series of "bear-trap" gates, each 11½ ft. long and supported by concrete buttresses, raises the level of the water in the reservoir 5 ft, or to a point 8 ft. below the top of the dam. These gates are operated by hydraulic pressure and are controlled by one 36 x 36 in. square and one 36-in. circular hand-operated gate, set in a concrete well at one side of the spillway. These gates are designed as an emergency feature to the spillway, making the total capacity of the spillway with the bear trap gates lowered 35,000 sec.-ft.

The outlet is of concrete and consists of a gate tower placed a little back of the inner toe of the slope, provided with three hand-operated gates, each 4 x 4 ft., placed on the front or outer side of the gate tower, making this a dry well to facilitate examination and repairs. There are three 4 x 4 ft. concrete conduits, heavily reinforced with twisted steel rods. Five concrete seepage collars, projecting 5 ft. on all sides of the conduit, were placed at intervals of 15 ft. along this conduit.

The reservoir was first filled in June, 1913, about thirty days after the embankment was completed and before the riprap or spillway was completed. A large flood at this time filled the reservoir in ten hours and ran over the spillway to a depth of 3 ft., doing considerable damage to the latter. A small seepage afterward developed close to the outlet, but at no time amounted to more than 1 cu. ft. per second, and up to the time of the break had apparently not increased to any appreciable extent. The reservoir was later drawn down to within 6 ft. of the outlet grade, at which point the water stood from September, 1913, to April, 1914.

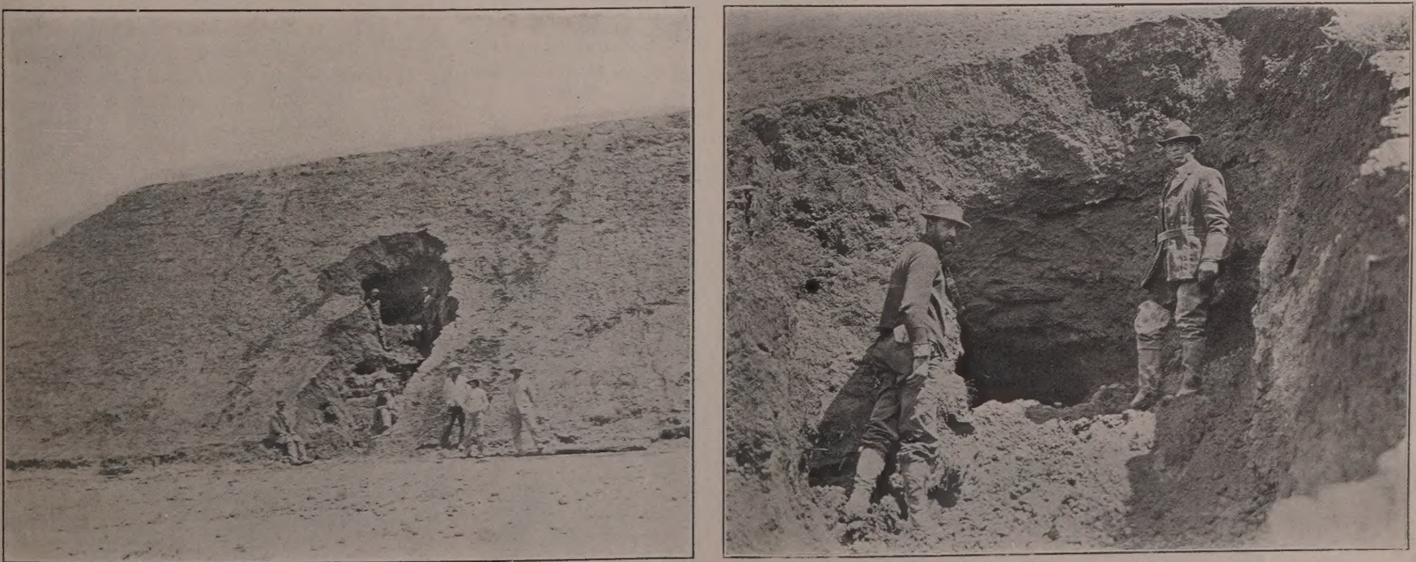
THE BREAK

On April 29 and 30 and May 1, 1914, from 6 to 10 in. of rain fell over the entire drainage area, and the reservoir filled rapidly, the water starting over the spillway on the evening of April 29 and increased steadily until 2 a. m. of May 2, when the break occurred. The reservoir was emptied through the breach in three and one-half hours.

The caretaker and two assistants were on duty to watch for settlement cracks or vermin burrows through the embankment, but at about 6 p. m. all had inopportunely crossed the spillway to seek shelter from the heavy rain and procure supper. At nine o'clock, when they attempted to return to the dam, the volume of water flowing through the spillway made it impossible to cross. The dam was therefore left without watchers from 6 p. m. until the break occurred in the morning.

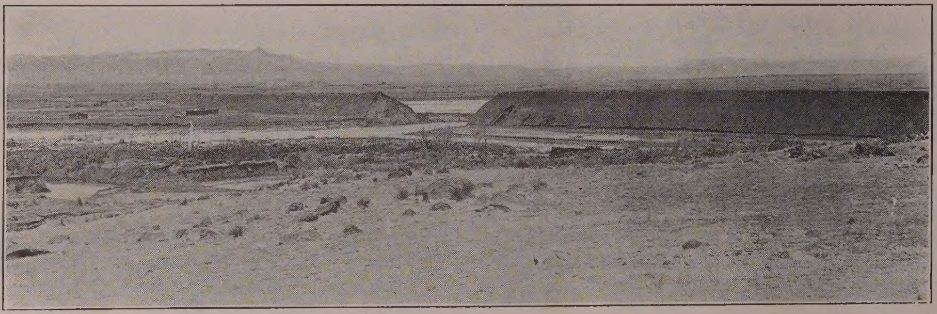
GOPHER HOLE THROUGH DAM

No one having witnessed the break until the breach was quite large, there is nothing but supposition and a small amount of evidence concerning how or why the break occurred. At this point the fill was 31 ft.



Two Views of Hole Believed to Have Been Made by Gopher and Enlarged by Passage of Water Through It high, and it is presumed that water started through either a gopher or other rodent hole, or a small crack, which was caused by settlement of the embankment. Not being checked, the flow gradually enlarged the channel until a considerable volume found egress and rapidly cut and undermined the comparatively soft embankment, making a breach 200 ft. in width before the reservoir was emptied. This breach is about 600 ft. east from the point where the seepage developed and at a point where no seepage was noticeable.

A short distance to the east of the breach water started through what appears to be a gopher or other small animal hole. The photographs show a close view of this hole and the way it was enlarged on the outside of the embankment by the water passing through it. Upon exploration this hole shows no indication of a crack, and at a distance of 20 ft. from the outside face has gradually diminished to about 10 in. in diameter. At this point it is 37 ft. to the inner face of the embankment and 1 ft. below the level of the water at the high stage. It is evident that if the water had not stopped flowing through this hole for some reason (either on account of the hole caving in on the inside, and thereby stopping the flow, or because the surface of the water was lowered by the larger break) a breach sufficient in size to empty the reservoir would have been made at this point, probably in the same way and very similar to the one which did drain the reservoir.

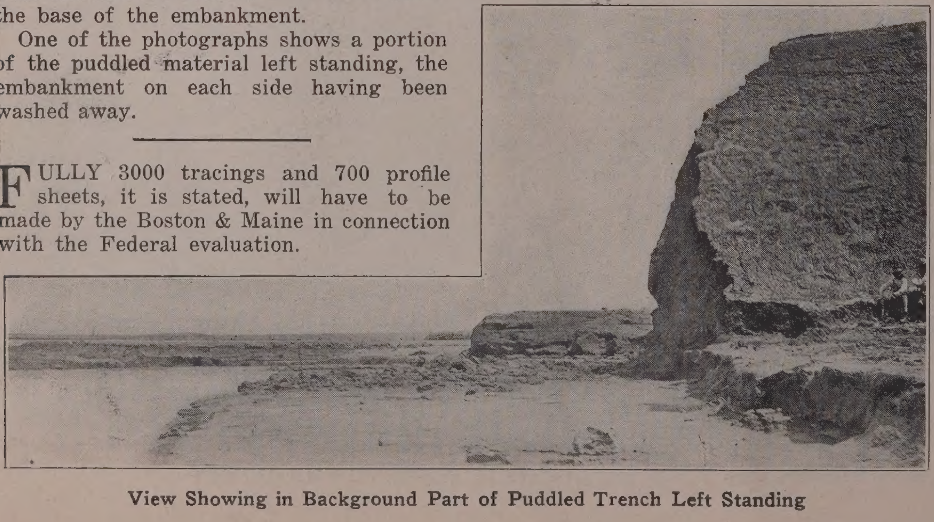


The 200-Foot Opening in the Hebron Earth Dam

ENLARGEMENT OF BREAK

At three o'clock on the morning of the break, at which time the caretakers were enabled to cross the spillway and get to the breach, a hole about 25 ft. wide had been made, the bottom of which was about 12 ft. above the base of the embankment. This hole rapidly enlarged until it was 200 ft. wide and had cut down to 10 or 12 ft. below the base of the embankment.

One of the photographs shows a portion of the puddled material left standing, the embankment on each side having been washed away.



View Showing in Background Part of Puddled Trench Left Standing

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FULLY 3000 tracings and 700 profile sheets, it is stated, will have to be made by the Boston & Maine in connection with the Federal evaluation.

Federal Railroad Evaluation

Four Months' Developments as Set Forth by General Secretary Thomas W. Hulme, of the Presidents' Conference Committee

A STATEMENT setting forth the developments in connection with the Federal valuation of the railroads has been issued by Thomas W. Hulme, Broad Street Station, Philadelphia, general secretary of the Presidents' Conference Committee. The statement relates to both the Government and the railroad organizations.

The Interstate Commerce Commission has created an accounting board with a member from each district, and a law and land department, consisting of a supervisor of land appraisals and five land attorneys.

The Presidents' Conference Committee has appointed a land committee and a committee "On Preparation of Financial Histories and Accounts," subdivided into group committees. Except for the Eastern group the personnel of the land committees is almost identical with that of the engineering committees. Group engineers have also been appointed in preparation for the study of cost data. These appointments, one for each group, have already been announced in this journal.

The various committees have had several conferences with the respective Federal boards. Since the adjustment of the matter of map specifications, already presented in the Engineering Record, the main subjects discussed by the engineering board are cost-data investigations, depreciation, abandoned property and classification of grading quantities.

As thus far developed the plan of cooperation involves (1) field work by the Government with a representative of the railroad, known as the pilot, present to point out all of the carrier's property not readily visible, and to agree, if possible, on the proper classification; (2) furnishing to the carriers of copies of the field notes taken by Government parties, these notes to be accepted as correct by both the Government and the carriers unless exceptions are taken within a certain period of time not yet fixed; (3) furnishing by the railroad of free transportation for the Government parties and supplies while inventorying the company's property; (4) furnishing and supervision by the railroad of labor to ascertain depth or classification of ballast.

Since Jan. 1 the general secretary has sent out (1) tentative instructions for field parties, prepared by the railroad engineering committee and submitted to the government engineering board; (2) a list of railroad valuation committees; (3) suggested instructions to field engineers relative to study of quantities and special features of construction not visible on field inspection; (4) a set of cost-data forms, one each for the accounts of engineering, grading, tunnels, steel bridges, frame and pile bridges and trestles, pipe and timber box culverts, stone box and arch culverts, ballast, track laying and surfacing, right-of-way fences, cross, switch and bridge ties, rails, track fastenings, and frogs and switches; a blanket form for buildings and other structures, and a sheet of general instructions, covering the use of all of the forms.

According to the lists furnished the general secretary by the Government, the following roads are now being surveyed: Norfolk Southern; Atlanta, Birmingham & Atlantic; Kansas City Southern; New Orleans, Texas & Mexico; Texas Midland; San Pedro, Los Angeles & Salt Lake. These roads are to be surveyed this year: Boston & Maine; Cleveland, Cincinnati, Chicago & St. Louis (part); Chicago & Eastern Illinois; Elgin, Joliet & Eastern; Central of Georgia; Chicago & North Western (south from Peoria); Great Northern (branches in North Dakota); Western Pacific. The following may also be taken up this year: New York, New Haven & Hartford; Philadelphia, Baltimore & Washington; Pittsburgh & Lake Erie; Minneapolis, St. Paul & Sault Ste. Marie (Fordville branch); Chicago, Milwaukee & St. Paul (Puget Sound portion).

Strength of Concrete-Steel Fence Posts

AN error in the log of tests in the article of William M. Stieve on "Concrete-Steel Fence Posts" in the issue of Feb. 14, page 186, has just come to light, and while the mistake is probably too obvious to be misleading, it is pointed out to correct possible misunderstanding. The average breaking load for posts made from run-of-bank gravel was 180 and not 18 lb., as compared with 185 lb. for posts made of crushed trap rock, with non-rusted wires.

The reinforcement for the T-posts was three five-gage and not five three-gage steel wires, as stated in the article.

FOREST FIRES due to railroads represented at least three-fourths of the total number reported for the winter season in the southern Appalachians, according to a bulletin from the U. S. Forest Service. Forest officers say that until the Southern States adopt and enforce laws requiring the use of adequate spark arresters on railroad locomotives losses from forest fires can scarcely be prevented.